New Scientist

WEEKLY 7 May 2022

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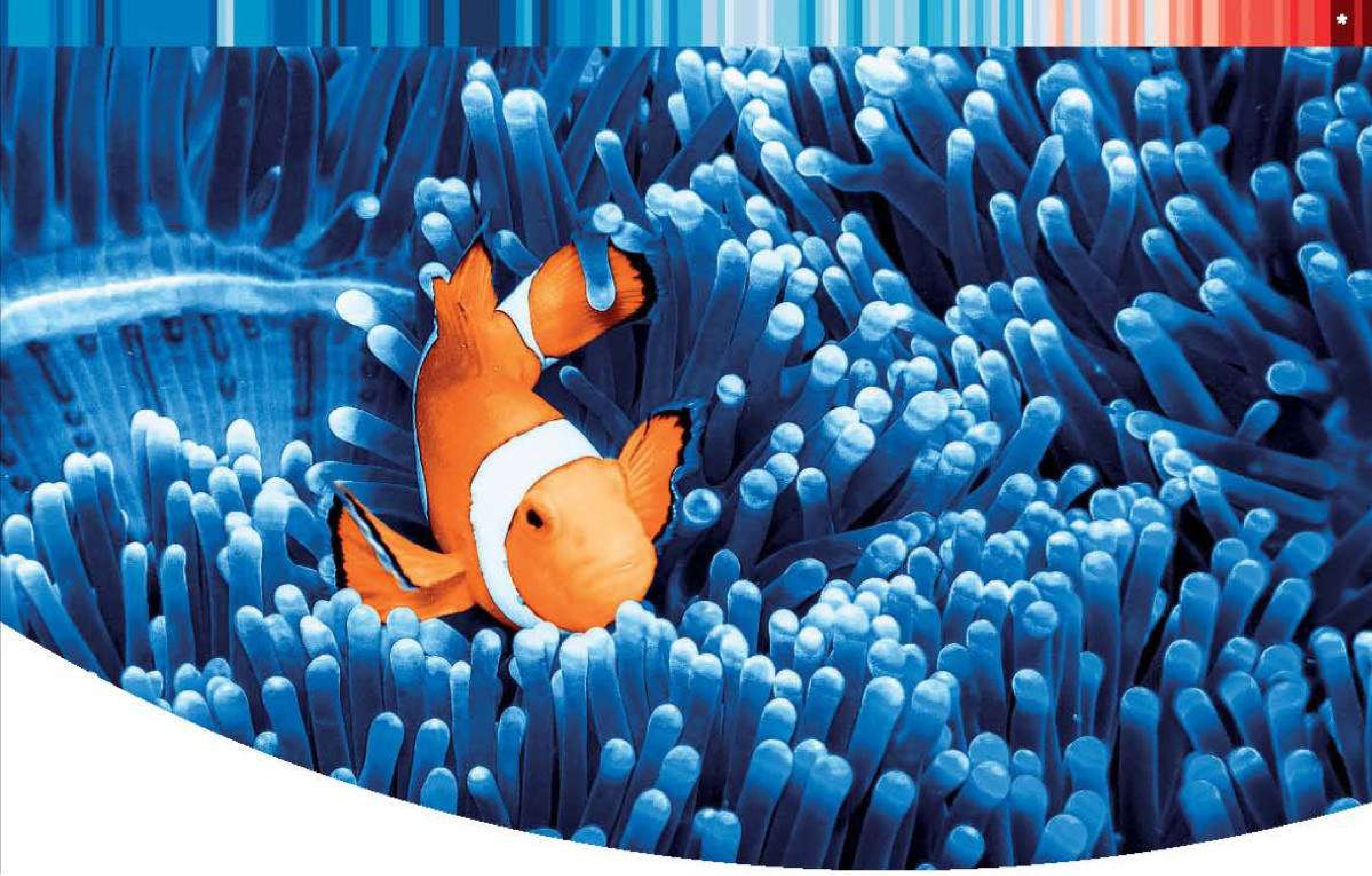

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Understanding the AI revolution

Artificial intelligence is emerging as one of the most important issues of our time. Join AI experts Beth Singler and Shakir Mohamed for an evening exploring key questions. Is AI really a threat? How impressive is it? How good will it get, and how soon? Conway Hall, London, at 7pm BST on 15 June.

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Podcast

Weekly

This week, podcast editor Rowan Hooper visits Wytham Woods in Oxfordshire, UK, to speak to biologist Ella Cole. He takes a look at some baby great tits and hears how spring has jumped forward nearly a month since research began at the forest 75 years ago. Meanwhile, the rest of the podcast team resurrects the ancient theory of whether life on Earth could have an extraterrestrial origin.

newscientist.com/nspod

NICOLE MILLIGAN

Spring forward Strange things are happening in Wytham Woods, UK

SHUTTERSTOCK/YURCHANKA SIARHEI

Inside you Ever wanted to know more about your genetic blueprint?

Video

Jumping jack

Tune into our YouTube channel to watch a springy robot jump more than 100 times its own height, take a behind-the-scenes tour of the British Library's National Newspaper Building in Boston Spa, UK, and see how a male orb-weaving spider avoids being eaten after sex by launching itself away at an impressive 88 centimetres per second.

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Newsletter

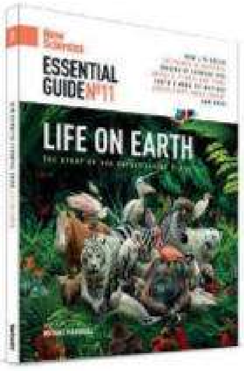
Fix the Planet

Chief reporter Adam Vaughan discusses new figures that show just how big the chasm is between countries' rhetoric on halting deforestation to tackle climate change and the chainsaw-and-fire-driven reality on the ground. Plus, find out how Indonesia is turning the tide on this issue.

newscientist.com/fix-the-planet

Podcast

> **"I reckon it's the most studied scrap of land in the whole world"**



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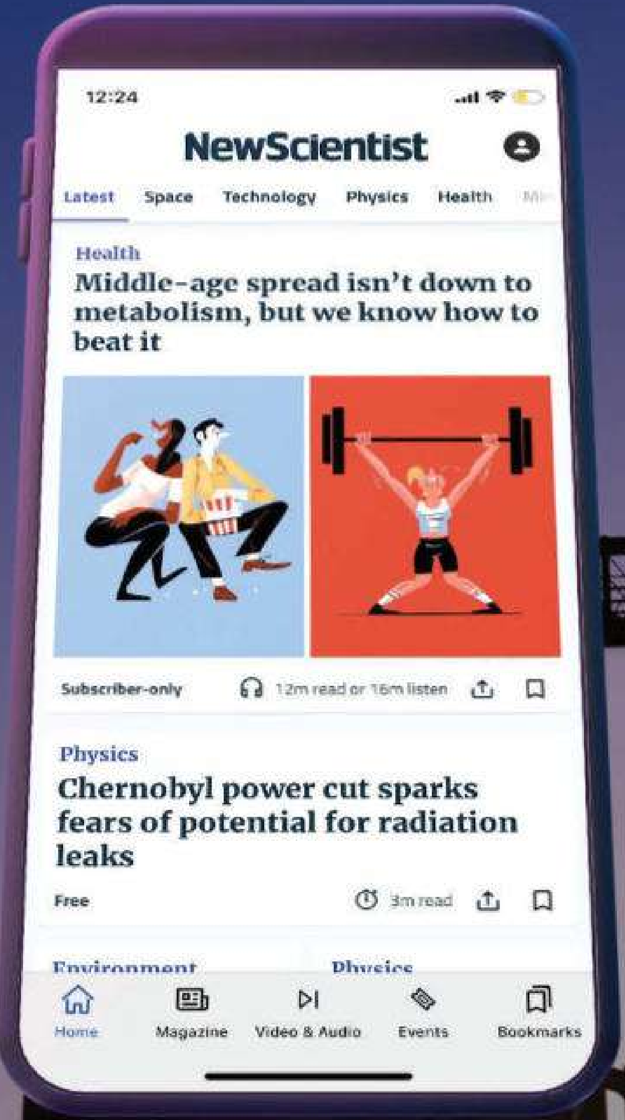

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Chernobyl power cut sparks fears of potential for radiation leaks

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The pandemic's long tail

We will be living with the secondary impacts of covid-19 for years to come

A MYSTERIOUS outbreak of liver disease, or hepatitis, in young children in the UK and several other nations is puzzling experts. The lead hypothesis is that the cases are connected to a normally mild adenovirus called 41F, plus another unknown factor that is making children react abnormally to catching it (see page 9).

The most likely suspect is that babies and infants went unexposed to the usual childhood infections over the past two years of social distancing. Or it could be that the affected children have had a recent brush with covid-19. Either way, the pandemic is in the spotlight.

The hepatitis outbreak is out of the blue, but it is unlikely to be the only pandemic-related health surprise awaiting us in the coming years. Many immunologists had already been predicting that covid-19 would have some longer-term effects aside from long covid. Young children normally catch every illness going around, but rates of common infections such as flu and stomach bugs plummeted in places that locked down. Many babies born in the past two years have had an abnormally long delay before they first encounter these illnesses.

> "Many of us experienced a drop in physical activity during the stricter periods of lockdown"

There are other indirect health effects of covid-19. Some research indicates that mental health has worsened during the pandemic, especially in young people. Many of us experienced a drop in physical activity during stricter lockdowns, too. This is concerning, as exercise is a great way to lower the risk of a range of conditions, from cancer and heart attacks to depression. An Age UK survey in August and September 2020 found that some older people had become less steady on their feet or less confident about walking to the shops.

This doesn't mean lockdowns were wrong. They stopped health services from being so swamped they couldn't see everyone who needed help, for covid-19 or other conditions, saving countless lives. In places where they did sometimes get overwhelmed, like India and Hong Kong, some people died avoidably for this reason.

But we shouldn't shy away from investigating all possible fallout from the pandemic, to cut the risk of further nasty surprises. We can't do anything to mitigate these effects if we remain in ignorance. ▮

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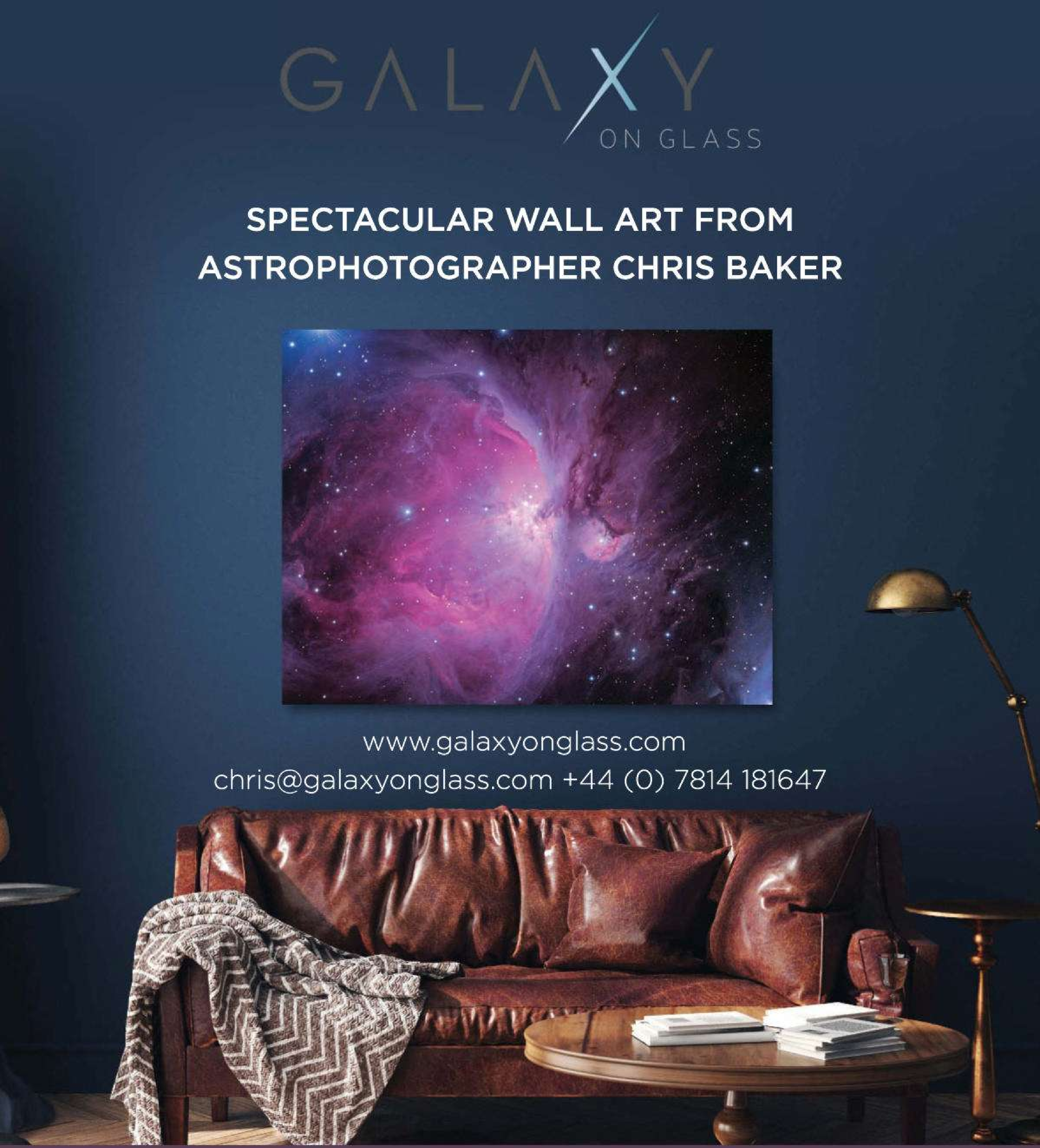

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Drone crime US plan aims to help police take out aerial threats p9

Dummy astronauts Mannequins will gauge radiation risk for women p16

The high life Mice found living near summit of volcano p19

Unwanted thoughts How the brain keeps some memories buried p20

Before Stonehenge Uncovering the prehistoric site's early significance p23

The Electron rocket as it blasted off, and moments before it was captured (inset)

ROCKET LAB

Space

Catch a falling rocket

A partially successful attempt at grabbing a rocket with a helicopter is a historic first, report **Jonathan O'Callaghan** and **Alex Wilkins**

A US launch company is the first to catch a rocket falling back to Earth in mid-air using a helicopter, though the manoeuvre was only partially successful as the helicopter was forced to drop the rocket into the ocean below.

The company, Rocket Lab, caught one of its Electron rockets shortly after it launched from New Zealand's Māhia peninsula at 2250 GMT on 2 May. The mission, dubbed "There and Back Again", involved the small rocket taking 34 satellites to Earth orbit, including one to monitor Earth's light pollution.

Around two and a half minutes after launch, the first and second stages of the rocket separated. The latter continued to carry the satellites to orbit, while the first stage booster fell back to Earth. As it fell, it reached temperatures of 2400°C and speeds of more than 8000 kilometres per hour, before deploying a series of parachutes to help slow its descent to around 35 kilometres per hour.

A Sikorsky S-92 helicopter then used a long cable to hook the booster by its parachute. Despite an initially successful catch, the helicopter pilots recorded "different load characteristics" to previous capture tests and were forced to dump the rocket booster into the ocean, where it was later recovered by ship. The original plan was for the booster to return to land without touching seawater, which can cause salt damage.

"Trying to catch a rocket as it falls back to Earth is no easy feat," Rocket Lab's CEO, Peter Beck, said in a statement before the launch. "We're absolutely threading the needle here."

At 18 metres tall, the Electron rocket is relatively small, about a quarter of the size of SpaceX's Falcon 9, the leader in reusable rockets. Yet Rocket Lab hopes to follow in the footsteps of SpaceX by making its rockets reusable to reduce costs, albeit via mid-air capture rather than landing on the ground or floating barges.

Rocket Lab has practised parachuting its rockets back into the ocean on previous launches, and recently captured a dummy rocket with its helicopter. ▮

Environment

Pollution makes coral less resilient

AREAS of coral reefs closest to land-based development and pollution are less likely to survive when ocean temperature spikes.

After a marine heatwave hit Hawaii in 2019, Greg Asner at Arizona State University and his colleagues wanted to know how its reefs fared.

"We're trying to figure out, how bad is it for these corals? Which corals, in which areas?" says Asner.

With colleagues, Asner flew a small aeroplane over the area, outfitted with a special infrared spectrometer to measure differences in the spectrum of light emitted by corals. This can reveal whether corals are living or dead.

The team's analysis of more than 200 square kilometres of reefs around six Hawaiian islands revealed that corals in some areas were up to 40 per cent more likely to survive than those in neighbouring reefs.

The best predictor of coral loss was the health of the reef before the heatwave. More specifically, areas of the reef nearest to coastal development or sediment run-off were more likely to die (*PNAS*, doi.org/hsjm).

"It's a one-two punch that's killing coral, which is heat, plus pollution," says Asner. He is already using the results to help inform conservation efforts in the area, with the goal of reducing damaging pollution where corals have managed to hold on. ▮

Corryn Wetzel

Nuclear safety

Call for robots at Chernobyl

After Russian troops destroyed radiation sensors at the nuclear plant and placed landmines around it, scientists seek other methods to monitor safety, reports **Matthew Sparkes**

DRONES and robots could aid in a new radiation-monitoring system at Ukraine's Chernobyl power station, because scientists there fear that existing sensor networks built after the nuclear accident in 1986 have been at least partially destroyed by Russian troops.

When Russia seized Chernobyl in February, sensors monitoring gamma radiation levels quickly went offline and most remained that way. The exclusion zone around the plant had a network of 67 sensors linked wirelessly with a base station at the plant. An older network of 28 gamma radiation sensors are physically wired to the central base station.

Olena Pareniuk at the Institute for Safety Problems of Nuclear Power Plants (ISPNPP) in Ukraine, which oversees research at Chernobyl, says there was no need or plan to upgrade the sensors at the start of this year. Since then, much has changed. Russian troops have now retreated, but scientists haven't been able to return to their labs because vast areas of the exclusion zone are now littered with landmines.

Limited visits by ISPNPP staff to the site revealed that computer servers and other equipment used to collect and back up radiation data have been destroyed or stolen. Pareniuk says the sensors, which are housed in small, steel buildings, may have appeared to be military equipment to Russian troops and may have also been actively targeted. She says there is hope that some sensors in more isolated parts of the exclusion zone remain, but she is pessimistic about the extent of the damage they may have incurred.

At the International Conference on Nuclear Decommissioning and Environmental Recovery, held online on 28 April, Pareniuk said that she and her colleagues believe vital historical information has been lost and their ability to take new readings has been destroyed.

"All servers and software were stolen and we know nothing about the destiny of the monitors that were mounted outside," she told *New Scientist*. "The current monitors are most likely ruined, so we will have to think about the next ones. It's quite obvious that we'll need a new monitoring system. And to make something new, you need to learn from all of the experience that we already have globally."

Japanese scientists at the conference shared their experiences in the wake of the Fukushima Daiichi nuclear plant meltdown in 2011. Tatsuo Torii at Fukushima University described efforts to take soil samples while also surveying radiation levels across the country from the air using helicopters and drones, and collate the two. "Monitoring from the sky is a very effective method to quickly determine a contamination distribution over a large area," he said.

Pareniuk says that any approach that stops people from exploring Chernobyl's exclusion zone by foot could save lives, because of the landmines placed there.

Another tactic suggested was robotic exploration. Although rudimentary robots trialled in the wake of the Chernobyl disaster suffered failures due to radiation damage, technology has since improved and radiation levels in the area have waned.

> "All servers and software were stolen and we know nothing about the destiny of monitors outside"

Yannick Verbelen at the University of Bristol, UK, has tested a portable sensor that can monitor radiation levels and even detect individual isotopes from a distance. It can be mounted on a tripod and was tested before the invasion on a quadruped robot from Boston Dynamics surveying radiation levels at Chernobyl.

DR YANNICK VERBELEN

A portable radiation sensor mounted on a Boston Dynamics robot

Verbelen says these robotic devices may be able to roam the exclusion zone and safely map radiation levels in fine detail. His team has also worked on using drones to map radiation, with devices that cost as little as £420 and sensors that bring the total cost per machine to about £12,600.

Although there are technical solutions to the problems caused by the Russian invasion, price will be a factor. Even so, Pareniuk and her colleagues will recommend the restoration of the existing network, as well as a nationwide expansion and robotic surveys.

Anatolii Nosovskyi, director of the ISPNPP, has said that money to repair and replace equipment won't be available while Ukraine is at war and will be difficult to secure even in the aftermath. Funds are also needed elsewhere, such as an estimated £42 million to build a road between the Chernobyl site and Slavutych, where many of the plant's scientists live, without passing through Belarus, which has assisted Russia's invasion.

But the funds will need to be found if the Ukrainian and global scientific community is to safely monitor the world's most contaminated nuclear site. Mike Wood at the University of Salford in the UK said at the conference that it is vital to have accurate data.

"Being able to definitively explain what happened and why is important," he said. "It's important to ensure confidence in the gamma ray-monitoring network, and that's important from a public reassurance perspective. It's also important because this network is a core part of the international safeguards for nuclear sites. Radiophobia is easily resurrected." ▮

Technology

US to bolster its ability to combat lawbreaking drones

David Hambling

THE US hopes to fight criminal use of drones with new rules that will allow local law enforcement agencies and other bodies to have counter-drone systems.

At present, legal restrictions in the US hamper efforts to tackle such activity. The Federal Aviation Administration bans anyone from interfering with an aircraft in flight, including drones, while the Federal Communications Commission forbids jamming radio signals, a common anti-drone technique. Only a few federal agencies are allowed to shoot down drones in extreme circumstances, such as threats to critical infrastructure.

US police agencies have been clamouring for counter-drone systems in the face of increasing criminal and careless use of drones. Drones are routinely used to smuggle drugs into the US from Mexico and into prisons, and have interrupted airport operations on numerous occasions. Swarms of drones have intruded over US nuclear power plants and sites believed to house nuclear weapons.

On 25 April, the White House announced its Domestic Counter-Unmanned Aircraft Systems National Action Plan. It will expand the authority of various federal agencies and pilot the use by local law enforcement agencies of counter-drone systems. These will probably include radio-frequency jammers that block communication between a drone and its operator.

"The creation of a nationwide strategy is a good development and the plans offer some positive changes, especially around airport protection," says Zak Kallenborn at the National Consortium for the Study of Terrorism and Responses to Terrorism in Maryland. But he fears that the limited pilot scheme will mean that many local law enforcement agencies will still struggle to tackle criminal drones. ▮

Medicine

Adenovirus is prime suspect in child hepatitis outbreak

Clare Wilson

SEBASTIAN ROSE/GETTY IMAGES

DOCTORS in the UK are investigating whether an adenovirus is behind an unexplained outbreak of liver disease in young children, as case numbers rise in countries including the UK, the US and Israel.

As of 21 April, there had been 169 identified cases of hepatitis, or liver inflammation, in 11 countries. Some people have been quick to blame the outbreak on either covid-19, its vaccines or lockdowns. But in the UK, which has had the largest number of identified cases, doctors said on 29 April that the cause is still unknown.

Their leading hypothesis is that the culprit is a usually mild adenovirus, a common cause of infection in children, along with a second, undetermined factor.

By 29 April, there had been 145 cases of hepatitis in the UK of unknown cause in under-16s, mostly in children below the age of 5. The covid-19 vaccine can't be responsible, as it isn't offered to the very youngest children in the UK.

The condition has been striking children without underlying health conditions. Most of those affected have recovered, but 10 children in the UK needed a liver transplant and so will need to take drugs that suppress their immune systems for the rest of their lives.

169

Cases of hepatitis in children worldwide in the outbreak

The leading suspect at the moment is an adenovirus called 41F, which usually causes nausea, diarrhoea and fever. Some kind of adenovirus was found in 40 out of 53 of the children who were tested for it in England. Out of 11 cases where adenovirus was detected in the blood and could be identified, all were the 41F type.

What could the unknown second factor be? "It must be in some way linked to the pandemic," says Deirdre Kelly at the University of Birmingham, UK. Of the 60 children with hepatitis who were tested for the coronavirus on arrival at hospital, 10 were positive, a rate of about 17 per cent.

Could low immunity be leading to hospitalisations?

A report from the UK Health Security Agency (UKHSA) says this "is not unexpected, given the community prevalence across the period of the investigation", but it is looking into whether a previous covid-19 infection could be the second factor.

Another idea is that the current cases are merely ones that were "delayed" because children had less chance to get infected with the 41F adenovirus over the past two years. When England's first lockdown began in March 2020, infection rates of all adenoviruses in 1 to 4-year-olds plummeted. They returned to previous levels in late 2021, shot up to about three times their former rate in February and have since been falling.

However, the hepatitis outbreak seems to have been too sudden to just be delayed cases. What is more, the 41F adenovirus doesn't normally cause severe hepatitis like this, even rarely, says Kelly.

The idea that the outbreak is connected with lockdowns – or rather, the return of social mixing after a period when it was lower than normal – is the UKHSA's leading hypothesis. There have been fewer childhood infections in general going around during the pandemic, not just adenoviruses, and immune responses against some pathogens can give partial protection against others.

"These children have not encountered their normal childhood viruses," says Kelly. ▮

Encryption

Quantum technique could stop people faking their location

Karmela Padavic-Callaghan

CREATING a fully secure method to verify the location of a device or computer isn't possible with classical computers, but now it seems it will be with quantum ones.

Matthias Christandl at the University of Copenhagen in Denmark and his colleagues have developed a system for verifying location that takes advantage of special properties of the basic units of memory in quantum computers, known as quantum bits, or qubits.

1m

The number of qubits a hacker would need in order to fool the new system

Suppose you wanted to verify the location of a device. With the new system, you would connect it to two quantum computers that would then exchange a combination of quantum and classical information. The data is transmitted in such a way that it would be impossible for a scammer to spoof or copy it without being detected. This is because information stored on a qubit can't be copied surreptitiously.

The team found that exchanging a single qubit and a million classical bits would be enough to make the system secure against anyone with a quantum computer smaller than a million qubits. In other words, tricking the system would require a quantum computer thousands of times larger than any that currently exist (*Nature Physics*, doi.org/hr58).

Adrian Kent at the University of Cambridge says the new protocol should be simple to implement on existing quantum computers. And Gilles Brassard at the University of Montreal in Canada says the work is the most exciting result in the field in a decade.

Christandl says he aims to tweak and simplify the approach until it could run on a device no bigger than a credit card chip.

Space

Meteorites on Mars may harbour signs of life there

Jonathan O'Callaghan

EVIDENCE of ancient life on Mars could be lurking in meteorites on the surface of the planet – and such rocks could be investigated by current and future rovers on the Red Planet.

Meteorites that fall on Earth are known to experience rapid contamination by microbes. These can leave telltale markers of their presence behind.

For instance, some may burrow into the meteorite and create microscopic tunnels. Others might subtly change the chemical composition of the rock. But it was unclear how well meteorites might preserve this evidence.

To address this, Alastair Tait at Monash University in Australia and his colleagues analysed seven meteorites they found on the Nullarbor plain in southern Australia, some of which landed up to 40,000 years ago.

They found that all of them contained evidence of fossilised microorganisms, as well as chemical changes wrought by the microbes (*Astrobiology*, doi.org/hr4g).

About 3 billion years ago, Mars may have had the necessary conditions for life, including a thicker atmosphere and liquid water on its surface.

Tait says that any meteorites that fell on Mars before or during this period, in a habitable location, could have been contaminated by Martian life in the same way that meteorites falling to Earth become contaminated by terrestrial life. "They would have essentially been a time capsule," he says.

Áine O'Brien, who is at the University of Glasgow, UK, says that meteorites on Mars were already known to offer a "really good" record of the geologic history of the planet.

"They are pristine when they arrive and distinct from the Martian surface," she says, so they could feasibly contain a record of past habitability. "If there was life, you would expect to see evidence of that."

However, meteorites that have been sitting on the surface of Mars for billions of years will have been bombarded by radiation, and this may have erased any such evidence, she says.

Dozens of meteorites have been found on Mars by various rovers. Tait says such rocks could be prime targets to look for signs of ancient life, both by NASA's Perseverance rover that is currently on Mars and collecting samples to return to Earth, and ESA's upcoming ExoMars rover, which has been delayed by Russia's invasion of Ukraine.

Tanja Bosak from the Massachusetts Institute of Technology, part of a team selecting samples for Perseverance to collect for possible return to Earth, says there are no plans for the rover to gather meteorites yet.

"It's hard to recognise a rock as a meteorite," she says. "We don't have the time to stop and examine all random rocks."

Sara Motaghian at Imperial College London, however, is developing analytical tools for ExoMars's cameras to quickly identify meteorites on Mars. She says the same tools could be used by Perseverance.

"We can study them with the drill or by crushing them with the wheels," she says, noting that the interiors of some meteorites on Mars could even provide shielding from radiation and be "tiny habitats" for life that may be there now.

Even if the rovers don't directly sample meteorites, Tait says that some samples returned by Perseverance could contain meteoritic material mixed into the Martian soil.

> **"Meteorites that fell on Mars when it was habitable could carry signs of Martian life"**

A meteorite on Mars photographed by NASA's Curiosity rover

NASA/JPL-CALTECH/MSSS

Signal Boost

Welcome to our Signal Boost project – a page for charitable organisations to get their message out to a global audience, free of charge. Today, a message from **Mummy's Star**

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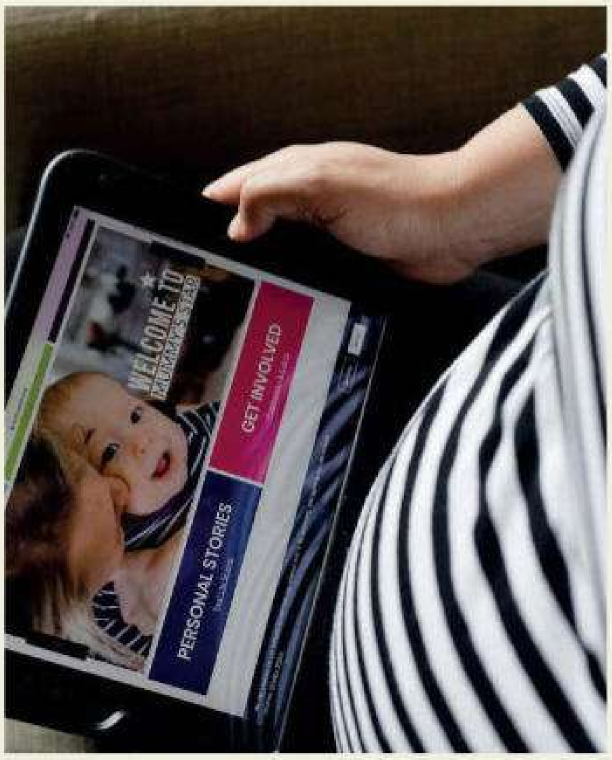
CANCER SUPPORT IN & AROUND
PREGNANCY | BIRTH | LOSS | BEYOND



Help us to help people diagnosed with cancer when they are pregnant

Every day in the UK, two women are diagnosed with cancer in and around their pregnancy. Mummy's Star is here to support them through diagnosis, pregnancy, birth, loss and beyond.

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We also run a Cancer and Pregnancy Training and Education programme for midwives, healthcare professionals and students. Last year, Mummy's Star saw:

- 462 families supported
- Over 2500 attending our education sessions
- Over 4000 support communications sent to families and their partners

WHO FUNDS THE WORK OF MUMMY'S STAR?
Mummy's Star relies exclusively on the generosity of its supporters. It does not receive any funding from the NHS. Donations come from families who have been supported by the charity, companies and grant-giving trusts.

WHAT OUR SUPPORT LOOKS LIKE

- Regular check-ins by phone or video call, and ongoing communications regarding treatment, surgery, pregnancy-related concerns and general wellbeing. We also offer virtual drop-ins and evening calls to ensure people can access support more easily.

- Dedicated support forums that offer a safe space for 450 mums and expectant mums diagnosed with cancer to ask questions and talk to others going through similar experiences. The forums are a lifeline for women as it helps them feel less isolated and alone.

- Signposting - where additional help is needed, the Support Team can make referrals to specialist services and other agencies to ensure each woman can access support to suit her and her family's needs.

- Monthly "Ask The Expert" sessions to give mums the opportunity to ask specific questions about important topics to an expert in that field. Topics have included menopause, pain management and talking to children about cancer.

- Training and Education programme – bespoke sessions for midwives, GPs and other healthcare professionals to raise awareness about cancer in and around pregnancy, how to spot potential signs, how to escalate concerns and how best to provide care post-diagnosis.

- Small Grant Programme to help families with the additional costs that are often incurred with a cancer diagnosis. The grant may be used to pay for childcare while mum attends appointments, specialist lightweight baby equipment for after surgery, activities to help families make memories or to help mum buy a wig to boost her self-esteem.

Want to help?

Please help to support mums dealing with cancer in and around pregnancy
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Climate change

The moon has a small but noticeable effect on Earth's temperature

Adam Vaughan

THE moon appears to be having a tiny effect on Earth's changing climate that could hasten the point at which the world's 1.5°C warming target is breached.

The angle of the moon's orbital plane relative to the equator changes in a predictable 18.6-year cycle, but it wasn't known what impact this has on Earth's surface temperatures.

In a modelling study, Ed Hawkins at the University of Reading, UK, and his colleagues found that the cycle will have a modest cooling effect on global average surface temperatures this decade, followed by a slight warming one in the 2030s. The pattern could also partly explain a purported global warming slowdown in the 2000s.

The researchers believe this cycle changes how the tides affect the mixing between warmer waters at the ocean's surface and deeper, cooler waters, altering the rate at which the oceans can absorb heat.

"It's a pretty small effect," says Hawkins. The estimated size of both the cooling and warming effect is about 0.04°C. This is much smaller than the shift from the cooling La Niña weather pattern the world is currently experiencing to the warming El Niño one, he notes.

"[But it shows] that we do study the whole climate system, from the sun to the moon to the Earth. And we try and represent all of the factors we can think about, and how they might affect the climate," he says. While the moon's impact may be small, Hawkins says it warrants inclusion in models used to project future climate scenarios if further research confirms the findings, which haven't yet been peer-reviewed (EGUsphere, doi.org/hsjj).

A full moon over an iceberg in Saqqaq, Greenland

WILD WONDERS OF EUROPE/JENSEN/NATUREPL.COM

Without accounting for the moon's influence, climate models predict that the world will exceed 1.5°C of warming – a threshold nearly 200 countries aimed to avoid in the Paris Agreement – between 2028 and 2033. Factoring in the lunar cycle narrows the predicted range to 2029 to 2032. The timing of the current cycle also means that in low-emissions scenarios, the 1.5°C threshold is likely to be met around a year earlier than previously thought.

The influence of the moon adds another explanation for why the Arctic is warming faster than the rest of the planet, due to the structure of the waters there, says Hawkins.

Joeri Rogelj at Imperial College London, who wasn't involved in the study, says the research shows that the moon's effects are small and cyclical, and it is "extremely valuable" to understand both human and natural influences on Earth's temperatures. But he says the estimated impact on when 1.5°C will be reached is so small as to be insignificant, as it will "disappear in the noise of global [temperature] observations".

Piers Forster at the University of Leeds, UK, who also wasn't involved with the study, says the mechanism for how the moon is affecting global temperatures is "definitely plausible, but its importance is uncertain". ▮

Palaeontology

Flightless prehistoric swan paddled the seas near Japan

AN ENORMOUS swan lived in the sea around what is now Japan and had stubby wings that it may have used to cradle offspring on its back.

Hiroshige Matsuoka at Kyoto University and Yoshikazu Hasegawa at the Gunma Museum of Natural History in Japan analysed a fossilised skeleton excavated in the Usui river in Japan in 2000. Deposits there date to the Miocene epoch more than 11 million years ago. Comparing the skeleton to modern swans, the pair identified it as a new genus and species, dubbed *Annakacygna hajimei*. A second, larger species from the same genus was identified by the same pair from a fossilised leg bone found at the nearby Kabura river in 1995, named *Annakacygna yoshiiensis* (*Bulletin of Gunma Museum of Natural History*, vol 26, p1).

The *Annakacygna* genus differs considerably from modern swans. The two extinct species are flightless sea dwellers. *A. hajimei* was the size of a modern black swan (*Cygnus atratus*) and *A. yoshiiensis* was about 30 per cent larger, on a par with Trumpeter swans (*Cygnus buccinator*), the largest of North America's living swan species. But *Annakacygna* had a substantially heavier build than modern swans, with dense bones. The researchers think this frame probably provided stability as the birds navigated choppy seas.

Annakacygna were also "head heavy", with big, broad bills for filter-feeding surface plankton, says Matsuoka. Their short wings are unusual for swans. The forearm bones were just over half the length of the upper arm bones. In modern swans, these are the same length.

"It had dense bones and a massive frame, which probably provided stability on choppy seas"

The muscles and joints of the wing may have helped produce courtship displays, and when combined with a tail that arches upwards, the wings may have made a cradle to transport hatchlings.

Such great specialisation in feeding and reproduction make *Annakacygna* the "ultimate bird", says Matsuoka. ▮

Jake Buehler

New Scientist Academy

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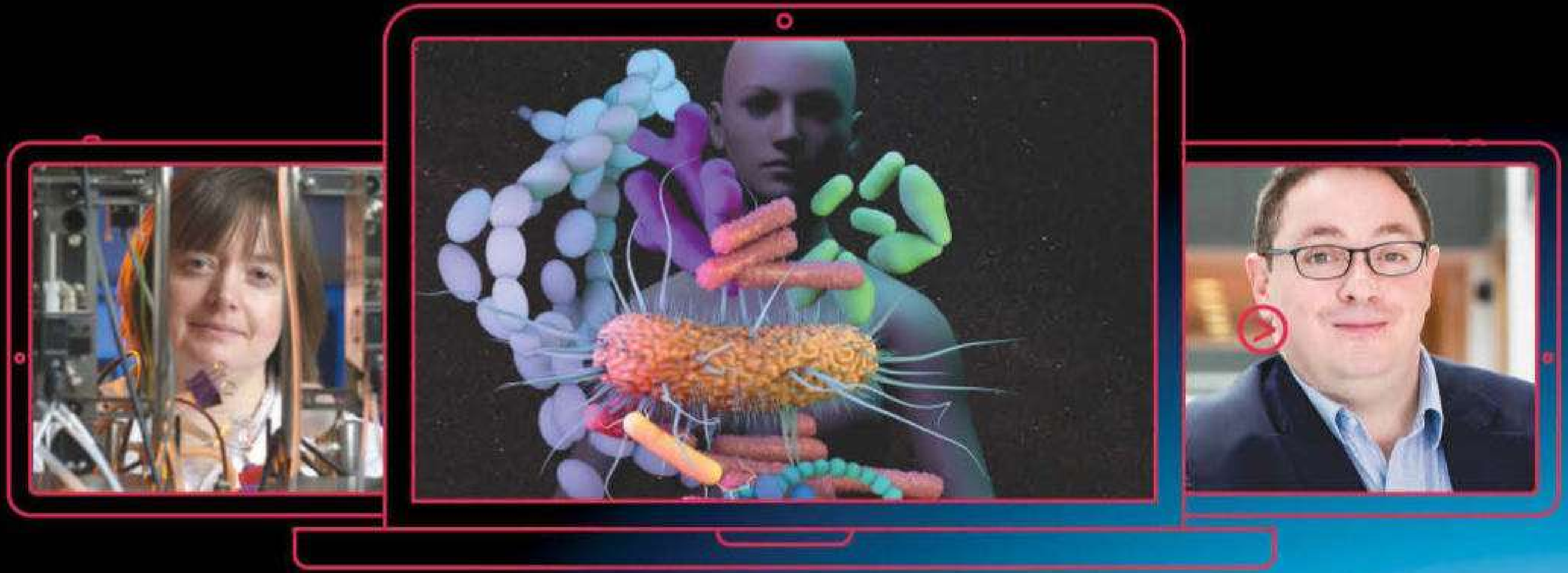

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Particle physics

Why is the W boson so heavy?

The particle's unexpectedly high mass has sent physicists scrambling for explanations that include a strange new Higgs particle and supersymmetry, reports **Leah Crane**

SHUTTERSTOCK/ANDREY VP

The mass of the W boson could upend the standard model of particle physics

80.379

Previously known mass of the W boson in gigaelectronvolts

80.4335

The latest mass measurement of the W boson in gigaelectronvolts

1 in 3.5m

Chance of getting a result like the new W boson mass value by fluke

ON 7 April, researchers announced results from the now-defunct Tevatron collider in Illinois finding that the mass of the W boson is higher than the standard model of particle physics predicts – a shockingly solid measurement that could demand new physics. Ideas to explain it have already begun flowing in earnest.

The W boson is one of the particles that carries the weak nuclear force in the same way that a photon carries electromagnetic force. It is also important to interactions between neutrinos and other subatomic particles. Before the Tevatron measurement, all of the modern observations of its mass clustered around 80.379 gigaelectronvolts.

The new result puts it at 80.4335 gigaelectronvolts, which is different from the previously observed value with a statistical significance of 5 sigma – meaning that there is about a 1 in 3.5 million chance of finding a value like this by chance if the old one is actually correct. A decade of data analysis by the Tevatron team has made it apparently one of the most secure particle physics measurements in modern memory.

The W boson mass anomaly indicates that something about the standard model is wrong or incomplete. This is shocking in one sense because the standard model has been extraordinarily accurate in its predictions thus far, but it isn't necessarily surprising in that we already knew it was incomplete – the model contains no explanation of dark matter, the prevalence of matter and antimatter in the known universe or even gravity.

Since the Tevatron results were announced, particle physicists have produced numerous papers explaining how the standard model could be adapted or expanded to account for the higher W boson mass. "What we are finding is that it is very easy to accommodate this anomaly – it's almost a bit surprising that this is so easy to do," says Ramona Gröber at the University of Padua in Italy. "In the past, with particle anomalies, it has been far more difficult to accommodate them."

Many of those explanations involve a strange or additional Higgs boson, the fundamental particle coupled to the Higgs field, which provides other particles – including the W boson – with mass. "The most obvious mechanism to justify a larger mass of the W is either a non-standard Higgs or a different number of matter fields [similar to the Higgs field], or a combination of both," says Francesco Sannino at the University of Southern Denmark. "There are a lot of variations on the theme, but these are the basic mechanisms."

"Even such a simple change as adding a second Higgs boson is able to accommodate the value that we observed," says Ashutosh Kotwal at Duke University in North Carolina, who was part of the Tevatron team. "There are grand schemes and there are simple schemes, and the ones I find the most intriguing are the ones which are the simplest."

Possible new particles

The various additional Higgs bosons that have been suggested have a range of properties different from the known Higgs. Some carry electric charges, while the regular Higgs boson is neutral. Some are made up of other, smaller particles – in some models, these are known particles, such as gluons making up what is called a glueball Higgs – and in others they are potential new particles, such as so-called techniquarks making up the possible Technicolor Higgs. In all of these models, the new Higgs particles come with additional fields that lend extra mass to the W boson.

Many of them also aim to solve other open questions in particle physics. For example, a popular model that accounts for the W boson's extra heft would add a new type of particle called a leptoquark that could explain another major mystery in particle physics – the muon g-2 anomaly, which arises from the fact that muons seem to rotate faster than the standard model predicts.

One set of possible particles, called supersymmetric particles or "sparticles", would accommodate a more massive W boson, the muon g-2 anomaly and the mystery of why fundamental particles in general have the masses that they do, in one fell swoop.

"We expect the new particles this supersymmetry predicts to have masses that are not much heavier than the Higgs", which is at the upper mass limit that the Large Hadron Collider (LHC) at CERN near Geneva, Switzerland, can probe, says Peter Athron at Nanjing Normal University in China. This would explain why we haven't spotted them yet.

Some of the new suggested particles could also be candidates for dark matter, potentially another reason why they haven't been detected.

Combing through these many ideas to find the correct one would require time, tests and, in some cases, a new generation of particle colliders. "By no means will a new mass of the W be enough to select a new theory of nature," says Sannino.

However, before particle physicists gallivant off in search of more particles and a new theory of nature, they will need to thoroughly check the Tevatron measurement.

"It is premature to think of any new physics at this point, before we figure out why this measurement is in discrepancy with the other measurements we have," says Matthias Schott at CERN, who worked on a previous W boson measurement using the LHC. "Obviously, new particles is a much cooler explanation, but all the other measurements of the W boson mass just fit together perfectly, and there's this one that doesn't fit."

Schott and his colleagues have already begun checking the new measurement against data previously gathered by the CMS and ATLAS detectors and the LHCb experiment at CERN, and they should have results in the next six months to 2 years, he says.

Depending on what those results say, the search for new physics may be on.

Aviation

EU plan to cut emissions from planes may increase them

Michael Le Page

PROPOSED European Union aviation regulations could see greenhouse gas emissions from flying increase, even while they are claimed to be sustainable, if some nations get their way.

The ReFuelEU regulations now being negotiated would require commercial flights in the EU to start using "sustainable aviation fuels", with the proportion added to standard fuel rising from 2 per cent in 2025 to 63 per cent by 2050. But the fuel's definition is currently up for discussion – and may end up including those that lead to an increase in emissions.

Under the original proposal put forward by the European Commission, sustainable aviation fuels would consist mainly of advanced biofuels derived from waste as well as synthetic fuels created using renewable energy. Biofuels made from food and animal feed wouldn't count.

Overall, this is good, says Chelsea Baldino at the International Council on Clean Transportation, a non-profit research organisation. But suggested amendments to the legislation would include food-based biofuels, she says.

A plane landing at Amsterdam Schiphol Airport in the Netherlands

NICOLAS ECONOMOU/NURPHOTO VIA GETTY IMAGES

That is a problem because such biofuels use land that is needed to grow food for people or farm animals. To maintain food supplies, more land would have to be cleared for agriculture around the world. If the emissions from these indirect effects on land use are counted, they "could negate some or all of the [greenhouse gas] emission savings of individual biofuels", a 2019 European Commission report states.

"The devil is in the details when it comes to biofuels. Some do more harm than good"

Food-based biofuels also push up food prices, hitting the poorest people hardest. "There is competition between land for fuel and land for food," says Ciarán Cuffe, a member of the European Parliament, who is part of the Green group. "Particularly in light of the war in Ukraine, we must prioritise land for food."

Another proposed amendment is that only biofuels that reduce emissions by at least 55 per cent should be eligible. While that sounds good, the suggested method for calculating emission reductions excludes indirect land-use effects, says Baldino.

"The devil is in the details when it comes to biofuels. Some do more harm than good," says Matteo Mirolo at Transport & Environment, which campaigns for cleaner transport. "It's very important that ReFuelEU gives the right signal and supports only the most sustainable biofuels."

Although biofuels made from waste such as used cooking oil can provide genuine reductions in greenhouse emissions, there are limits to the amount of waste available. "We simply don't have the resources to create the quantity of biofuel needed to keep up with the rocketing demand," says Cuffe.

This can lead to fraud. For instance, Cuffe says it appears that some biofuels sold as being made from used cooking oil are actually being made partly from fresh palm oil.

For these reasons, Cuffe, Baldino and Mirolo would all like to see caps imposed on the quantities of biofuels allowed.

Instead of biofuels, Cuffe thinks ReFuelEU should prioritise the use of e-kerosene made using renewable energy, electrolysis and direct air capture of carbon dioxide. Firms are poised to hike production if policy-makers send investors a clear signal, he says.

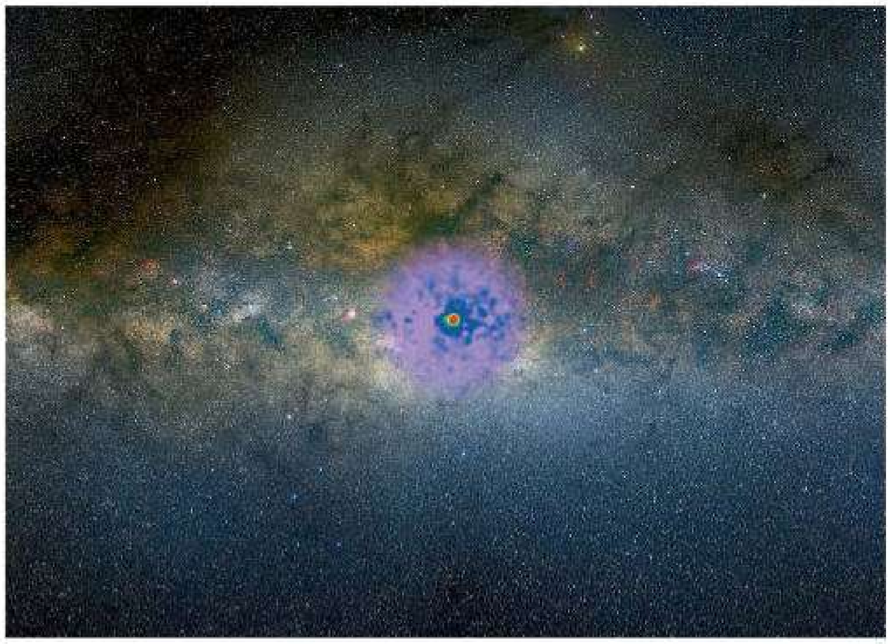
ReFuelEU should also apply to private jets, not just commercial flights, says Cuffe. Negotiations on the wording will continue until later this year, he says, and the final outcome is hard to predict.

"The definition of sustainable aviation remains a hugely divisive topic and positions among member states vary greatly," an EU official told *New Scientist*. Discussions are ongoing, they said, and the European Council has yet to reach a common position.

Astrophysics

Milky Way's gamma-ray glow could be from pulsars

Will Gater



NASA GODDARD; A. MELLINGER, CMU; T. LINDEN, UNIV. OF CHICAGO

The Fermi Gamma-ray Space Telescope's view of the galactic centre

A MYSTERIOUS gamma-ray glow in the inner parts of our galaxy could be due to thousands of dead stars spinning at hundreds of times a second. These millisecond pulsars are formed from the remnants of stars that have used up all their fuel, but now blast out radiation. A similar thing might also be happening in the nearby Andromeda galaxy.

The enigmatic glow, called the Galactic Centre Excess (GCE), was first identified in 2009. Since then, several ideas have emerged to describe how it might be formed. One hypothesis posits that the radiation is created when dark matter particles meet and annihilate, releasing gamma-ray light, while another points the finger at millisecond pulsars. In the latter case, astronomers had largely been focusing on millisecond pulsars whose origins lie in binary star systems where one star has experienced a violent supernova explosion.

Now, Roland Crocker at the Australian National University, Canberra, and his colleagues have suggested that another type of millisecond pulsar – those formed when a massive white dwarf rips material from a star before collapsing and transforming into a whirling pulsar – can produce a characteristic gamma-ray light that tallies with what astronomers see coming from the Milky Way's centre (*Nature Astronomy*, doi.org/hr4d).

While that on its own doesn't rule out dark matter annihilation as a possible source of the GCE, it does present an alternative phenomenon that can "explain the entirety of the signal", says Crocker. "My own view is that the best interpretation now is that not only is the GCE astrophysical rather than dark matter in origin, we know the specific astrophysical sources responsible for it," he says.

This finding is complemented by a separate study looking at a gamma-ray glow coming from the nearby Andromeda galaxy. Fabian Zimmer at the Gravitation AstroParticle Physics Amsterdam Centre in the Netherlands and his colleagues created maps of where old stars are located within the galaxy, using these as an indicator for where millisecond pulsars are expected to exist.

Adding this information to their model of gamma-ray production revealed that the potential contribution from the pulsars was enough to account for the level of gamma rays seen emanating from Andromeda (arxiv.org/abs/2204.00636).

"In other words, there was no more 'room' for the dark matter, as almost all of the excess was already explained by the other components used in our study," says Zimmer.

Crocker believes future research will show that the glow from Andromeda is caused by the same type of millisecond pulsars that his team suggests causes the GCE. "It's entirely reasonable and, indeed, consistent with the evidence that both excesses share a similar origin," he says.

Jeff Grube at King's College London says the Cherenkov Telescope Array (CTA) project being built in Chile and the Canary Islands will observe the inner Milky Way to investigate the GCE further.

CTA should also be able to help study Andromeda by looking for as-yet-undetected higher-energy gamma rays coming from any millisecond pulsars, says Alison Mitchell at the Erlangen Centre for Astroparticle Physics in Germany. "If [the higher energies are] not detected, this can constrain the hypothesis that millisecond pulsars are responsible for the emission." ▮

Space flight

Test dummies gauge radiation risk for female astronauts

Alex Wilkins

IT'S one small step for a mannequin, one giant leap for womankind. Mannequins designed to represent female bodies will be sent into space for the first time later this year to study how radiation affects women in space.

NASA aims to send the first female astronaut to the moon as part of its planned series of Artemis space flights. The first mission, Artemis 1, will be an uncrewed test flight of the Orion spacecraft, which will head beyond the moon and back to Earth over four to six weeks.

Powerful radiation is abundant in space, but all previous studies of its effects on the human body have been on mannequins with a male form. But organs such as breasts and ovaries are particularly sensitive to radiation, putting women at a greater risk of cancer caused by radiation than men.

Thomas Berger at the German Aerospace Center in Cologne and his colleagues have designed a pair of mannequins to mimic female torsos and the organs within that will fly on the Artemis 1 mission. Named Helga and Zohar, each contains 5600 passive radiation sensors. Zohar will wear a radiation-blocking vest, whereas Helga will be vestless.

"You [will] get baseline data from the radiation load a human female would receive while flying in a spacecraft which is actually built for humans," says Berger. ▮

Mannequins named Helga and Zohar are designed to replicate female anatomy

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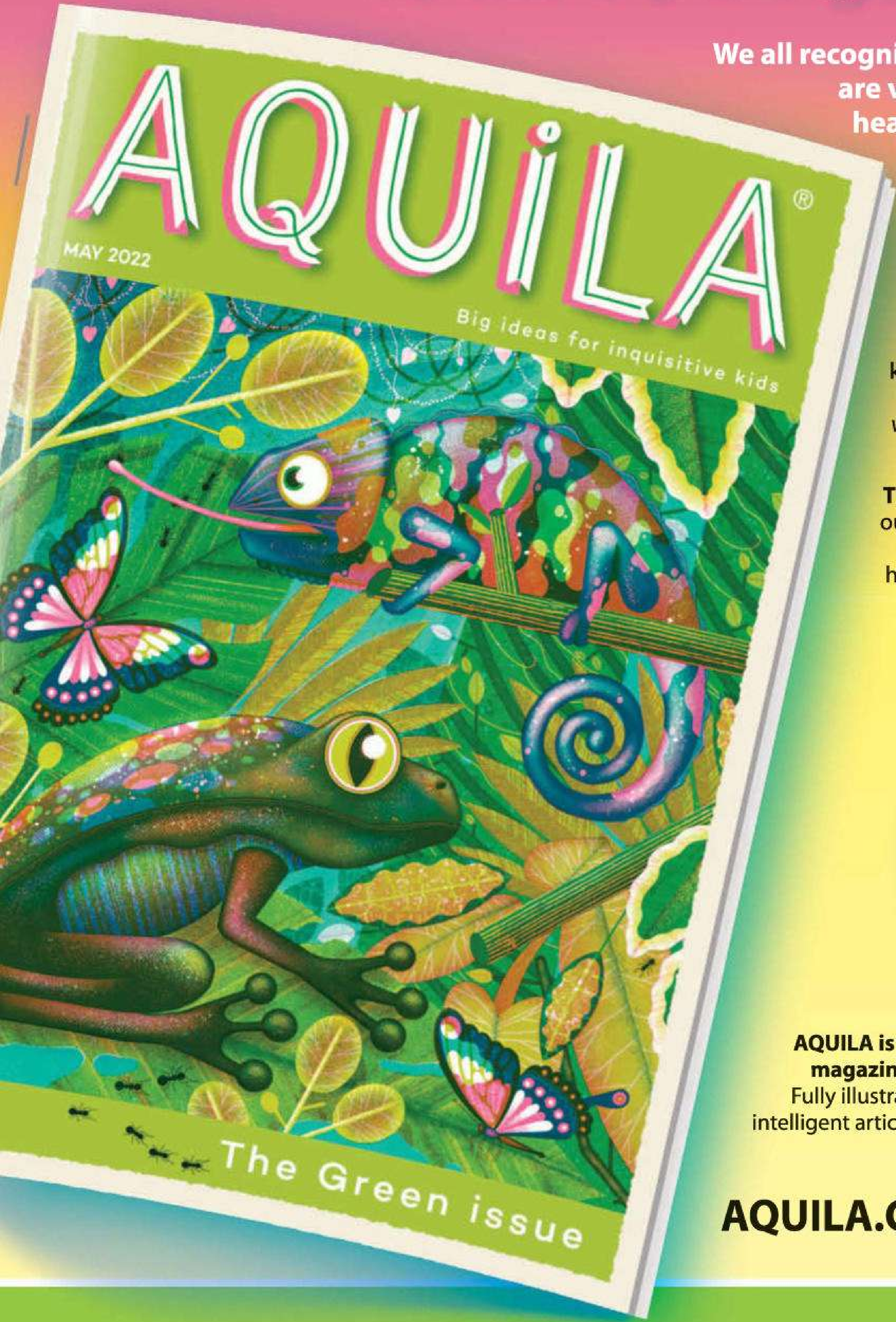

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Chemistry

Chemical waste can be recycled into a range of drugs and fertilisers

Matthew Sparkes

MORE than 300 ways to convert widely available chemical waste into a range of drugs and fertilisers have been identified by a software program. The researchers behind the tool believe it will optimise the chemical industry and allow the recycling of by-products that would otherwise need to be stored.

Bartosz Grzybowski at US software and chemistry company Allchemy and his colleagues used their software, also known as Allchemy, to look for useful products from 189 small molecules that are regularly created as by-products of large-scale industrial processes around the world. An additional 56 molecules that are commonly created from chemical waste during recycling processes were also included.

The software created a vast database of all the possible combinations of chemicals and the processes that could be used to combine them. Running on a single high-end server, the program took about a month to calculate the hundreds of billions of combinations. These were then narrowed down to only those processes that led to the creation of drugs, fertilisers or other useful molecules (*Nature*, doi.org/hrxd).

BERKE BAYUR/ANADOLU AGENCY VIA GETTY IMAGES

Workers at a chemical waste disposal facility in Ankara, Turkey

Grzybowski says that all of the discovered processes could eventually have been found by humans, but the vast scale of possible processes made them incredibly hard to spot. Among the discovered molecules were drugs to treat leprosy and heart disease, but Grzybowski says that his favourite result was an antibiotic that can be produced from lactate, which comes from waste plastic bottles, and phenol, a by-product of coal mining.

"I was hoping to find aspirin or something, but it's actually much more interesting than that," he says. "It actually solves the problem of circular chemistry, pretty much in an exhaustive way."

Grzybowski had previously worked on projects to create new methods to synthesise specific molecules, but he says that this software works in the other direction: it takes a list of available resources and finds all the possible uses for them.

"This chemistry is pretty straightforward. The difficulty is in spotting the opportunity," he says. "The building blocks are very simple, but when you start talking about 200 waste molecules, within one step of combinations you have 40,000 options."

Grzybowski says he hopes that Allchemy will eventually lead to a "Tinder for molecules". Chemical companies could put in details of all of their available waste products, other companies could list molecules they would like to have synthesised for a specific purpose, and third parties could bid to perform the waste-to-drug synthesis. This would reduce waste from the global chemical supply chain and perhaps also lower the cost of drugs and other products.

Judy Lee at the University of Surrey, UK, says identifying uses for chemical waste in the lab is useful, but scaling up that process may be more difficult. "Something that's developed in the lab needs to be translated in a profitable way into a large pilot scale," she says. "The purity of that compound is important as well. If you can't purify it enough to be useful, then there will be a problem." ▮

Wildlife

Volcano-dwelling mice are highest-living mammals

THE summit of Llullaillaco, a massive Andean volcano straddling the border of Argentina and Chile, is hostile to animal life: it is perpetually frigid, exceptionally dry and oxygen poor. But scientists found mice there in 2020, and their latest research adds to evidence that the tiny rodents may actually make the highest reaches of the volcanic peak their home.

A few years ago, Jay Storz at the University of Nebraska in Lincoln and Marcial Quiroga-Carmona at the Austral University of Chile in Valdivia, with other researchers, reported a new high-elevation record holder among mammals: a leaf-eared mouse now identified as belonging to the species *Phyllotis vaccarum*. It was captured on Llullaillaco's summit, which is 6739 metres above sea level.

However, there were still questions about whether the mice really spent their lives near the summit. Most documentation of altitude records for animals are based on single observations, says Scott Steppan at Florida State University, one of the researchers.

"It doesn't really tell you if [the animals are] adapted to that extreme elevation," he says. Individuals may visit high elevations briefly, while the population mostly lives at a much lower altitude.

MARCIAL QUIROGA-CARMONA

A leaf-eared mouse (*Phyllotis vaccarum*) found near the peak of Llullaillaco

Now, the team has pulled together more data to make the case that the mice sustain populations at, or at least very near to, the volcano's summit (*Journal of Mammalogy*, doi.org/hrsz).

For instance, the researchers analysed the microbial community collected from soil in a mouse runway – a route that the mice repeatedly scurry across – at an altitude of 6154 metres.

They discovered that it was dominated by animal-associated bacteria that imply a sustained presence of mice in the area. Elsewhere near the top of Llullaillaco, the soil mostly contains stress-tolerant fungi. ▮

Jake Buehler

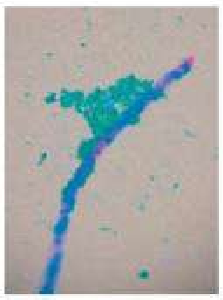
Environment

Microplastic particles stick to spiderwebs

Joshua Rapp Learn

TINY microplastic particles floating through city air stick to spiderwebs, giving researchers a natural way to capture and monitor this form of pollution.

Microplastics are being found widely in our food, soil and oceans. But researchers haven't extensively looked into how many airborne microplastic particles might be present in urban areas. This is a potential concern as they could be getting into our lungs and may have adverse effects on our health.


KAREN SHAPIRO, UC DAVIS

A piece of microplastic fibre seen under a microscope

Barbara Scholz-Böttcher at the University of Oldenburg, Germany, and her colleagues wanted to see whether they could trace the prevalence of these minute particles using spiderwebs.

The researchers collected webs around semi-covered bus stops throughout Oldenburg. The most common materials they found were polyester, probably from clothing, and tyre fibres that probably originate from vehicles braking in traffic (*Science of the Total Environment*, doi.org/hrxs).

Scholz-Böttcher says that this study could be used as a baseline to track the extent of trace particles in the air over time, or to compare the level of microplastics and tyre wear between different locations.

Christian Enyoh at Saitama University in Japan says the value of the approach might be limited as researchers can't ensure webs will be in a particular place. "For true evaluation of spiderweb potential, a laboratory-kind experiment should be done," he says. ▮

Neurology

Brain signal could stop you thinking unwanted thoughts

Jason Arunn Murugesu

HUMANS may have a warning system in the brain that helps suppress unwanted thoughts. Understanding this system could lead to treatments for obsessive-compulsive disorder (OCD) or post-traumatic stress disorder (PTSD).

Michael Anderson at the University of Cambridge and his colleagues analysed the brain scans of 24 Chinese-speaking people as they completed a memory task. They were asked to memorise 48 pairs of Chinese words. Each person then had electroencephalography (EEG) electrodes attached to their head and was put into a functional magnetic resonance imaging (fMRI) machine.

"We wanted to analyse the participants' brains in two ways simultaneously because fMRI is really good at telling you where things are happening in the brain, but it's no good at telling you about the timing of brain activity, whereas EEG is really good at that," says Anderson.

A screen displayed the words the participants had memorised, one at a time, alongside a green or red light, or no light. When the green light was shown, they were instructed to think about the word it had initially been paired with. A red light indicated they should try not to recall the paired word. No action was required for words that appeared with no light.

Each word pair was repeated 12 times in a random order and was always shown with the same – or no – coloured light.

> "The faster the warning signal, the less effort required by the brain to suppress a memory"

About 350 milliseconds after participants saw a red light, a brain region known for managing attention, called the dorsal anterior cingulate cortex, sent a signal to an area of the brain involved in working memory, called the dorsolateral prefrontal cortex (*Journal of Neuroscience*, doi.org/hrts).

The signal might be an alert for an unwanted memory, says Anderson, which the dorsolateral prefrontal cortex then works to suppress. "It takes about 500 milliseconds to consciously remember something that's associated with something else – so this signal is happening in your subconscious," says Anderson.

The team also found that people with a stronger warning signal were more likely to struggle with recalling paired words.

The bigger the warning signal fired, the less activity the team saw in the dorsolateral prefrontal cortex. This suggests that the stronger the warning signal, the less effort required by the brain to suppress a memory, says Anderson.

"The hope is that by tracing out how these mechanisms work in detail, we'll have the model system that we could apply to disorders like OCD, anxiety and depression, which all feature intrusive thoughts," says Anderson.

Annemieke Apergis-Schoute at the University of Leicester in the UK says a limitation of this study is that the word pairs used might not be relevant to the experiences of people with mental health conditions. "With PTSD and OCD, unwanted thoughts are very distressing," she says.

Anderson says that other similar studies previously conducted by his team used distressing stimuli that elicited activity in the same regions of the brain.

"The neural circuit identified in this intriguing study can provide a potential target for the treatment of intrusive thoughts in PTSD and OCD," says Benedetto De Martino at University College London. In the near future, he says, people may be able to train parts of their brain to exert more control over unwanted memories. ▮

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EEG headsets can be used to look at activity in the brain

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"The funding I received through the Medical Research Foundation will be transformative for my research." Dr Myrsini Kaforou

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>
> Professor Fiona Watt, Patron of the Medical Research Foundation and Director of the European Molecular Biology Organization.

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Archaeology

People visited Stonehenge site thousands of years before it was built

Michael Marshall

THE area around Stonehenge, UK, may have acquired enormous significance for Stone Age humans thousands of years before the famous monument was built, suggest archaeologists working at a nearby site called Blick Mead.

The Stonehenge monument was built between 3000 and 2000 BC. It is a ring of standing stones, surrounded by an earth bank and ditch.

Lying more than a kilometre to the east of Stonehenge is Blick Mead, the site of a spring where warm waters rise up through the chalky bedrock. Archaeologists have been excavating there for nearly two decades and have found over 100,000 stone tools and the remains of animals.

People visited Blick Mead long before Stonehenge was built – dating studies suggest there was human activity there between 8000 and 3400 BC. This indicates the first people at Blick Mead were Mesolithic hunter-gatherers, distinct from the Neolithic farmers who built Stonehenge.

These hunter-gatherers may have been drawn to the area because of the water source. Helen Lewis at University College Dublin in Ireland says springs often attracted prehistoric people and those sites became important.

Samuel Hudson at the University of Southampton in the UK and his colleagues have used data from Blick Mead to estimate what the landscape there was like during the Mesolithic period, which ran from 15,000 BC to 5000 BC in Europe. The researchers drilled down into the ground to examine and date the layers of sediment. They also identified pollen grains preserved in the sediment, which indicate the types of plants that grew in the area.

The team obtained plant DNA directly from the sediment, which revealed the area had been home to trees, wetland plants like buttercup and those that live in open grasslands, such as clover. The pollen studies confirmed this, revealing lots of grasses.

Stonehenge, UK, was considered significant by Stone Age humans

CHRIS GORMAN/GETTY IMAGES

The researchers concluded that Blick Mead and the surrounding area were a mixed habitat with some woodland and some open grassland.

Some of the clearances were probably made by large grazing animals like aurochs, the wild relatives of domestic cattle, bones of which have been found at Blick Mead. Mesolithic people may also have cleared some of the trees (*PLoS One*, doi.org/hrw8).

Hudson thinks that the partial clearances during the Mesolithic made it easier for later Neolithic farmers to clear wider areas. By the time Stonehenge was under construction, the area was probably largely treeless.

That is in line with evidence from other Stone Age monuments, says Lewis, who wasn't involved in the analysis.

Over time, increasingly formalised activities may have taken place in the area, culminating in the construction of Stonehenge. By that time, people may even have forgotten about the existence of the Blick Mead spring. ▮

Diseases

Virus spread among wild mammals may rise with warming

THE migration of land mammals in response to 2°C of global warming may give rise to thousands of new viral transmissions between mammal species by the end of the century, increasing the risk of novel viruses jumping from animals to infect humans.

"The coming decades will not only be hotter, but sicker," said Gregory Albery at Georgetown University in Washington DC, at a press briefing on 27 April. He and his colleagues used data on animal habitats and behaviour to build a model of how 3139 mammal species would migrate under a 2°C increase in global temperature.

By comparing how closely species were related – and therefore how likely they were to pass viruses to each other – the team predicts that about 120,000 encounters between mammals that hadn't previously met could lead to 4584 cases of novel viral infections of species (*Nature*, doi.org/hrxm).

"Climate change is shaking our ecosystems to their core… moving mammals will meet each other for the first time and form new communities, [which will create a] new mechanism for disease emergence that will threaten the health of animals in the future, with ramifications for our health too," said Albery.

The team forecasts that bats will be responsible for the majority of new transmissions, which will primarily occur in elevated tropical regions across Africa and South-East Asia. The findings highlight the need to more closely track the spread of viruses among wild mammals so we can control future outbreaks of disease in people.

"This spread is happening and not preventable even in the best-case climate change scenarios"

"This is happening and not preventable even in the best-case climate change scenarios," said Albery. Further work will be needed to confirm how rapidly animals will migrate due to warming. "We use an upper limit of how quickly animals might move, so we will need to establish how fast they actually move in the future," he said. ▮

Carissa Wong

FRANK HECKER/ALAMY

Biodiversity

Many species of reptile are at risk of being wiped out

MORE than a fifth of reptile species are at risk of extinction, according to the first global assessment.

Bruce Young at NatureServe, an international biodiversity organisation, and his team collated data from around the globe to assess the extinction risk for 10,196 reptile species, such as the Chinese crocodile lizard (*Shinisaurus crocodilurus*), pictured here.

By accounting for local factors such as habitat degradation and population size, they estimated that 21.1 per cent of reptile species are at risk of extinction (*Nature*, doi.org/hrwz).

The researchers found that farming, logging and urban development posed the largest threats, with species in tropical regions of South-East Asia, West Africa, northern Madagascar and the Caribbean islands at the highest risk. What's more, the analysis revealed that 31 reptile species have already gone extinct.

The results are worrying because these animals are a vital part of food webs. There have been relatively few conservation drives for reptiles, but efforts to protect other animals have probably helped to an extent.

The findings will feed into negotiations at the United Nations COP15 biodiversity meeting later this year, which aims to create a global deal for protecting wildlife.

"This information is vital to designing effective conservation measures, [and] understanding where reptile species may benefit from existing efforts and where conservation attention is lacking," says Nisha Owen at conservation body On The Edge. **Carissa Wong**

Materials

New diode could speed up computing

A SUPERCONDUCTING diode has been created for the first time. It could save vast amounts of power in traditional computing and help transform quantum computing.

The diode – an electronic component that lets electricity preferentially travel in one direction – is a fundamental part of the transistor, the foundational component of modern computing. Diodes and transistors are made from semiconductors that have electrical resistance, meaning energy is lost in the form of heat.

Superconductors have no resistance and so no energy loss, but they don't work as diode components, since resistance is how diodes ensure that electricity travels in only one direction.

Now, Mazhar Ali at Delft University of Technology in the Netherlands and his team have demonstrated a superconducting diode for the first time. They sandwiched a layer of a material called niobium-3 bromine-8 between superconducting layers. When electrons travel through the structure in one direction, they don't encounter resistance, but in the other direction they do. The result was so unexpected that Ali and his team don't fully understand how it works.

Computers and data centres use between 10 and 20 per cent of the world's electricity supply, much of which is wasted as heat from electrical resistance in transistors. Superconducting versions could use less power and possibly run much faster, says Ali. In addition, the diode could be crucial for advances in quantum computing.

Ali and his team now aim to use their discovery to build a superconducting transistor, but there are challenges. Their diode operates at around -271°C, which requires more energy to maintain than the diode might save (*Nature*, doi.org/hrws). **Alex Wilkins**

Health

A possible genetic cause of lupus found

THE DNA of a girl with a severe form of lupus may have helped uncover a genetic cause for the autoimmune condition.

Lupus causes inflammation that can lead to joint pain, skin plaques (pictured) and fatigue. The cause is a bit of a mystery, making it difficult to develop treatments. Most therapies dampen the immune system, leaving people more vulnerable to infections.

BIOPHOTO ASSOCIATES/SCIENCE PHOTO LIBRARY

To hunt for possible genetic causes, Grant Brown at the Australian National University in Canberra and his team sequenced the genome of a girl called Gabriela, who was diagnosed aged 7. Her age meant a genetic factor was more likely to be involved.

The work revealed that she has a mutation in a gene called *TLR7*, which encodes a protein called toll-like receptor 7. This normally helps the immune system spot foreign agents so it can mount suitable attacks against infections.

Mice given this mutation ended up with lupus-like symptoms. The mutation probably makes it harder for the immune system to tell foreign agents and healthy tissue apart (*Nature*, doi.org/hrwp).

However, such mutations have only been identified in two other people with lupus so far, suggesting the faulty gene isn't the only cause of the condition. Brown's team is now exploring whether drugs that target *TLR7* could treat lupus. **Alice Klein**

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Really brief

SHUTTERSTOCK/DOTTED YETI

Plesiosaurs could afford to look odd

Extinct marine reptiles known as plesiosaurs didn't have to be very streamlined. Their vast bodies generated drag, but as bodies get larger, the ratio of surface area to mass falls, which cuts the drag per unit of body mass that must be overcome, so their muscles could easily cope (*Communications Biology*, doi.org/hr39).

We instinctively run at an optimal speed

We seem to automatically run at a speed that minimises our energetic costs. In the real world, men tend to run at 3.3 metres per second and women at 2.7 m/s. Laboratory studies show that these speeds are energy-optimal for the two groups (*Current Biology*, doi.org/hrxc).

New tool estimates dog life expectancy

Dog owners can more accurately estimate the life expectancy of their pet on the basis of its breed and current age with a tool built using data from 30,000 dogs in the UK. Jack Russell terriers typically have the highest life expectancy (*Scientific Reports*, doi.org/hr4b).

Palaeontology

Ancient giants just got even bigger

AROUND 200 million years ago, ichthyosaurs dominated the sea. We knew these extinct reptiles could be as large as a sperm whale. However, palaeontologists have discovered the largest ichthyosaur tooth to date, suggesting they were even bigger than we thought.

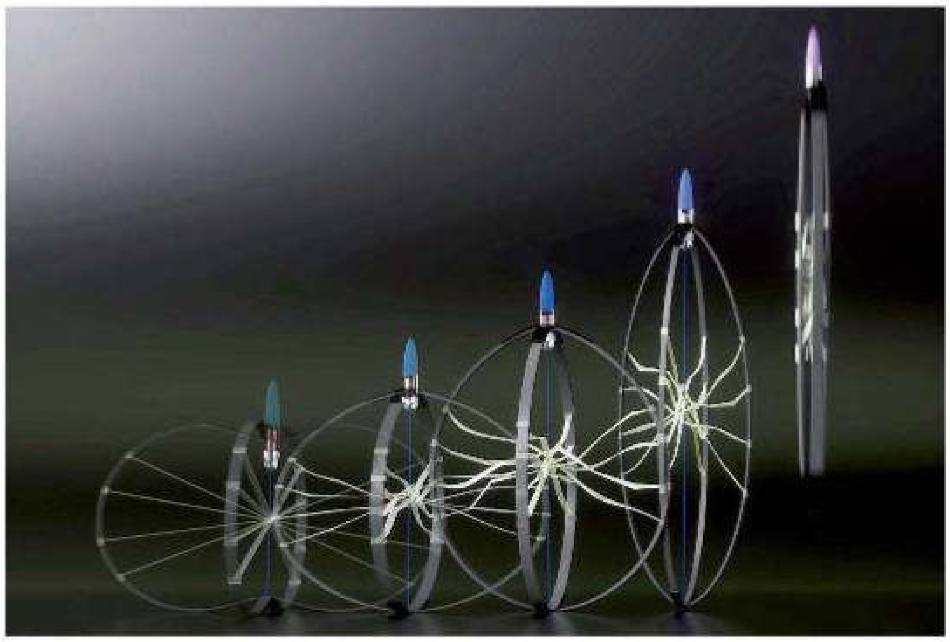
There are just a handful of ichthyosaur specimens around the world, with a giant black tooth and a collection of vertebrae and ribs from the Swiss Alps among them. Martin Sander at the University of Bonn in Germany first saw the Swiss fossils when they were unearthed more than 30 years ago, but they were shelved because new, seemingly better-quality ichthyosaur fossils were being found in Canada.

Sander and Heinz Furrer at the University of Zurich in Switzerland decided to take another look at the Swiss fossils, and realised they had evidence of three of the largest ichthyosaurs to date.

The crown jewel of their discovery is an ichthyosaur tooth with a root around 6 centimetres wide, which Sander says is the largest known specimen "by far". While palaeontologists only have the bottom portion of the tooth, "these big roots usually mean there is a big crown", says Sander. Vertebrae and rib fragments from one of the other individuals suggest that the reptile was around 20 metres in length.

Though the giant tooth infers a giant owner, Sander and Furrer aren't sure if it is from a massive ichthyosaur or a smaller one with particularly large teeth (*The Journal of Vertebrate Paleontology*, doi.org/hrxr). **Corryn Wetzel**

Technology



ELLIOT W. HAWKES

Robot with a spring in its step shoots for the moon

A ROBOT that can jump more than 100 times its own height could leap over challenging terrain on the moon and explore the rocky surface more quickly than a wheeled rover.

Elliot Hawkes at the University of California, Santa Barbara, and his colleagues developed a robot just 30 centimetres tall that can leap to a height of 32.9 metres powered by a carbon fibre sprung skeleton.

The robot weighs 30 grams and uses a system of gears to slowly compress the springs despite having only a small motor. This energy is then released rapidly to launch the robot into the sky. It lands on its side and can right itself by re-tensioning its springs and prepare to jump again (*Nature*, doi.org/hrwm).

Hawkes says that the same robot on the moon would be able to reach heights of 125 metres and traverse around half a kilometre per leap, making it good for exploration. "The moon is a truly ideal location for jumping," he says. "Gravity is one-sixth that of Earth, and there is basically no air." On Earth, about 25 per cent of the potential jump height is lost to air drag, says Hawkes.

"[The robot] could hop onto the side of an inaccessible cliff or leap into the bottom of a crater, take samples and return to a wheeled rover," he says. **Matthew Sparkes**

Electronics

Super-fast battery charges in minutes

A LITHIUM-ION battery that uses copper and copper nanowires to structure its anode can charge to 60 per cent in 6 minutes, without affecting its energy storage. It could one day be used to improve charge times for electric vehicles.

Yao Hongbin at the University of Science and Technology of China in Hefei and his colleagues made the advance by designing a new type of anode, which is the positive end of a battery.

Lithium battery anodes are typically made of graphite particles through which charge flows, with these particles generally arranged in a fairly random order. For their version, the researchers coated graphite anode particles with copper and mixed in copper nanowires, which allowed them to organise the particles by both size and porosity. The resulting battery charged to 60 per cent in 5.6 minutes and to 80 per cent in 11.4 minutes, while maintaining a high level of energy storage (*Science Advances*, DOI: 10.1126/sciadv.abm6624).

The researchers didn't record the time to get to a 100 per cent charge. Electric car manufacturers often recommend vehicles be charged to up to 80 per cent to maintain battery longevity. **AW**

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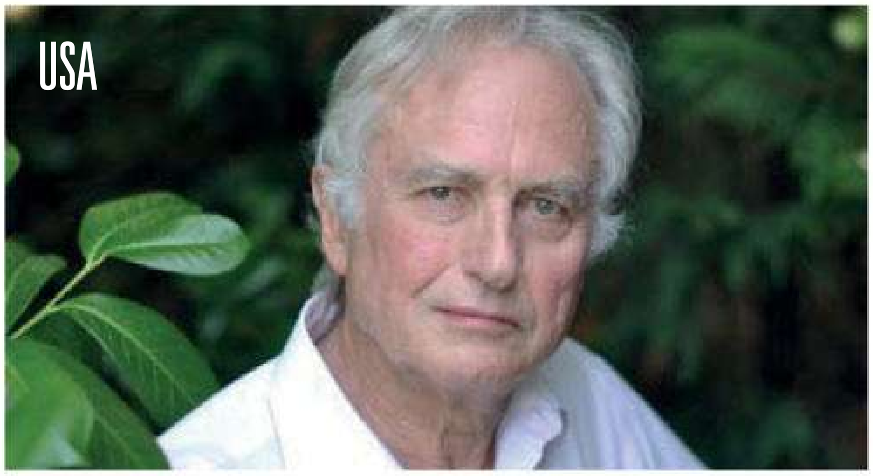

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Comment

End of the road?

Banning ads that push high-carbon products such as SUVs would be a win for regulators looking to take climate action, says **Andrew Simms**

FROM the car advert urging you to enjoy a life "without restrictions" by driving an SUV with emissions 250 per cent above the EU target to the airline ad mocking people who holiday at home, why, in a warming world, are we surrounded by ads encouraging us to buy polluting, high-carbon products? Ending them would be an easy win for decision-makers looking to take rapid climate action.

Ads promoting high-carbon lifestyles and products are ubiquitous. Car firms spent an estimated $35.5 billion on advertising in major global markets in 2018. SUVs were the second-largest contributor to the increase in global carbon dioxide emissions between 2010 and 2018. Following heavy promotion by vehicle manufacturers, in less than a decade, SUVs went from being 1 in 10 of new car sales to more than 4 in 10.

Once you start to look for such ads, they are everywhere. Sport is one of the world's biggest advertising markets. The three sponsors with courtside adverts at the 2021 Australian Open tennis tournament were an oil and gas company, an airline and a car-maker (Santos, Emirates and Kia).

Advertising wouldn't be the multibillion industry it is if it didn't work. One recent estimate looking at the degree to which global car and airline advertising increased demand suggests that it could have been responsible for between 202 million and 606 million tonnes of greenhouse gas emissions in 2019 – an order of magnitude ranging from between the Netherlands' entire emissions that year to almost twice those of Spain.

SIMONE ROTELLA

To a large degree, the advertising of high-carbon products has taken the place of once-common tobacco advertising, which ended in the UK in 2003 for health reasons. Now, with a climate crisis and an estimated 8.7 million premature deaths a year from burning fossil fuels, ads from big polluters should go the same way.

The latest Intergovernmental Panel on Climate Change report looked at how behaviour change could complement system change in achieving rapid emissions cuts. It lists regulation of advertising as an example of a policy measure that can have a "major influence on mitigative capacity".

The sheer incongruity of urgently needing to cut emissions while being surrounded by ads for gas-guzzling SUVs isn't lost on the general public either, as a new poll of UK attitudes illustrates. In a nationally representative survey of 2000 people, 68 per cent of UK adults said they would restrict advertising of environmentally harmful products, while 45 per cent favour limits on ads for highly polluting cars and 33 per cent support curbing ads for air travel.

Echoing the debate that led to the ending of tobacco advertising, around half said that warnings alone wouldn't alter their choices.

Regulators are beginning to look more at corporate "greenwash", such as airlines promising climate-friendly flights. France is requiring car adverts to carry environmental warnings and prompts to walk, cycle or take public transport instead. Amsterdam and five other Dutch cities have banned public ads for fossil fuel products. UK councils, including Liverpool, Norwich and North Somerset, have passed similar policies. A European petition for a new EU law to ban fossil fuel ads has raised more than 200,000 signatures.

Given the heavy lifting facing other climate measures, simply removing the advertising that pushes us to consume polluting products could prove an appealing option for policy-makers.

As with tobacco, stopping ads wouldn't prevent the harmful products from being sold, but it would reduce demand and the cultural normalisation of this damaging activity. ▮

Andrew Simms is co-director of the New Weather Institute and assistant director of Scientists for Global Responsibility

My botanical life

Keeping gardens green The rise in demand for exotic houseplants is damaging the environment. We need to make sure our gardening is sustainable, writes **Beronda L. Montgomery**

Beronda L. Montgomery is a writer, researcher and biochemist who studies how plants detect and respond to their local light environment. She is the author of *Lessons from Plants*. You can follow her on Twitter @BerondaM

Beronda's week

What I'm reading

The Cooking Gene: A journey through African American culinary history in the Old South *by Michael W. Twitty*

What I'm watching

At my sister's prompting, I have been watching the brave kids on Old Enough!

What I'm working on

I'm editing a thesis and dissertation for graduating students – a time to celebrate all they have accomplished!

OVER dinner with friends, one half of a couple proudly declared that his resourcefulness in finding local, sustainably caught fish had allowed a watershed for him, a carnivore, and his partner, a vegetarian-leaning pescatarian. Sustainable fishing is of critical importance, because demand for seafood has caused populations of fish and shellfish around the world to become endangered, as well as leading to habitat destruction.

When I mentioned that discussions of sustainable practices for harvesting plants and gardening are also increasingly recognised, and likewise hotly debated, my friends seemed surprised. However, gardening practices and the growing of houseplants can have significant sustainability issues.

A surge in interest in gardening occurred during the pandemic. In response, many people began to sound the alarm about myriad unsustainable ways that coveted, and sometimes exotic, houseplants were being obtained, from the energetic costs of commercial glasshouses and transport to the destruction of plant communities and ecosystems due to poaching.

Recent accounts of plant poaching abound. Plants targeted include in-demand Californian succulents, carnivorous pitcher plants found in the Philippines and endangered species such as succulent button plants and lithops in South Africa.

Since 2010, the slipper orchid has been rapidly depleted; less than 1 per cent of its original population remains, threatening it with extinction. And habitats are often damaged or destroyed by those illegally harvesting plants.

While the economic benefits for the poachers are driving much of the illegal trade, the long-term economic implications have yet to be fully counted by most.

The removal of plants by poachers isn't always a careful operation and it can result in physical damage to ecosystems and disruption to the soil. The roots of plants are important for maintaining soil structure and contributing to soil health. When roots are disturbed, soil erosion is accelerated.

The plants that are removed are also members of communities and their departure means the entire community is disrupted. This leads to a decrease in plant diversity.

> **"If our love for plants accelerates damage to the environment, then we need to question the roots of our love"**

The impact spans far beyond the immediate loss of plants. Plant removal affects the insect and bird populations that pollinate the plants and rely on them for food and habitation. And soil erosion, coupled with the reduction and potential extinction of plants that sequester carbon, can ultimately accelerate climate change.

What can you do to contribute to sustainable practices and still engage in a love for plants? My favourite option is to propagate plants through cuttings obtained from fellow plant lovers.

Many plants can regrow roots from a cutting – sometimes simply by placing the cutting in water and waiting. So if there is a rare plant I love, such as my prized variegated Monstera, I try to find someone willing to share a cutting rather than buying a specimen, especially if I can't determine whether the seller obtains their plants sustainably.

Another option is to buy locally, and to choose plant varieties endemic to the area. I have a sentimental attachment to the fragranced, bright red and orange trumpet-shaped flowers of the cross vines (*Bignonia capreolata*) grown by my grandmother and mother in Arkansas, where I was born and raised. But living in Michigan, some of the species that hark back to my youth can't be sustainably grown, as they need more water and fertiliser, or may be invasive.

Instead, I grow clematis varieties with large, beautiful flowers that are red, pink or wine-coloured, which are more ecologically friendly yet still strongly remind me of the beautiful blooms of my youth.

I also pay close attention to whether plants will require me to enrich my soil with peat – a major unsustainable gardening product that is found in almost every gardening centre – or if I will be able to use more sustainable compost.

Peat is derived from wetlands – moss-rich areas in some cases, or decomposed leaves and tree parts in tropical areas. It is often harvested faster than it can be organically replaced, thus leading to significant habitat erosion or destruction. Peatlands function as carbon sinks, so their destruction or overharvesting contributes significantly to climate change.

If our love for plants accelerates damage to, rather than honouring and protecting, the ecological niches in which they reside and thrive, then we need to question the roots of our love. We should cultivate a needed reciprocity, in which we care sustainably for the environments from which our beloved plants are derived. ▮

Up next week:
Chanda Prescod-Weinstein

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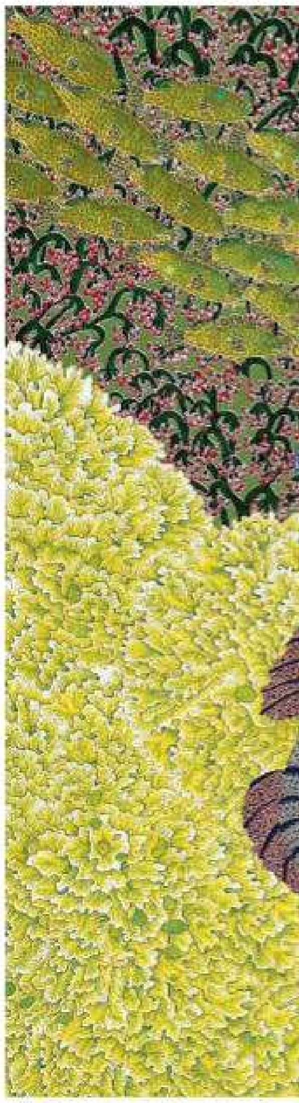
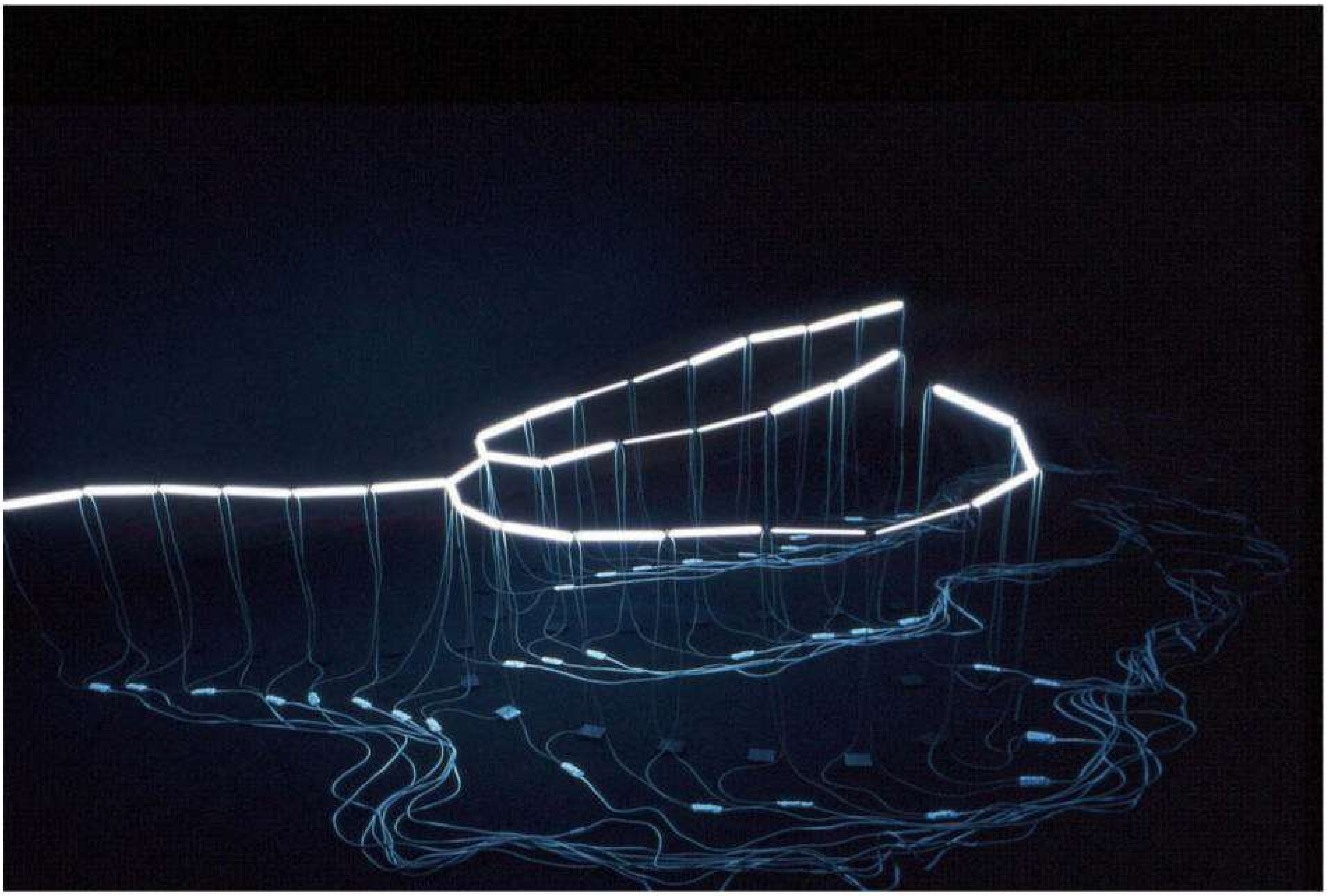




CLAUDE ZERVAS

Creative juice

Seattle Art Museum

FROM its pure essence to its significance in culture and society, water takes on rousing and inventive forms in these artworks from Our Blue Planet: Global visions of water, an exhibition at the Seattle Art Museum in Washington. The show explores one of the world’s most crucial resources through more than 80 artistic interpretations.

At top left is a still from *The Boat People* by Tuan Andrew Nguyen. Shot in the Philippines, the film follows five children as they travel by sea, collecting objects. At top right is *The Garden of Earthly Delights V*, Raqib Shaw’s mixed-media depiction of mystical underwater creatures, inspired by Dutch painter Hieronymus Bosch.

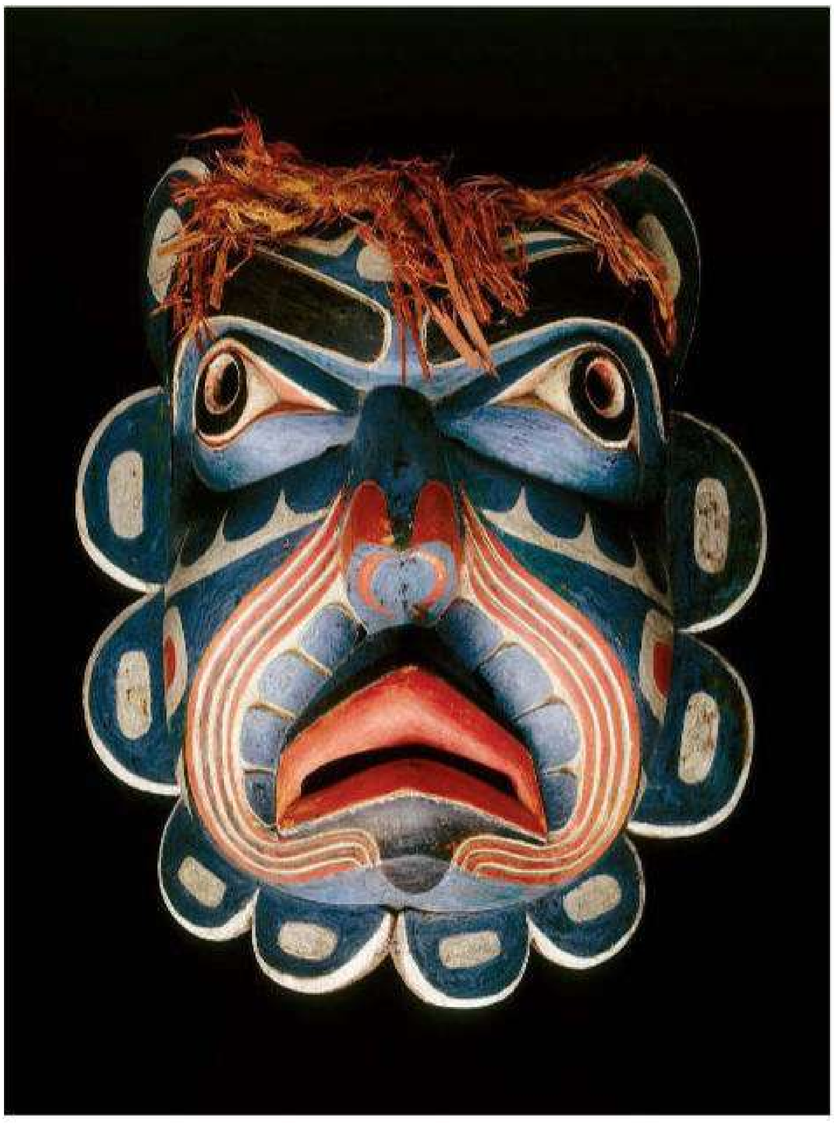
The bottom row shows (left to right): *Nooksack*, a sculpture by Claude Zervas made from wire and cold-cathode fluorescent lamps that mimics the form of the Nooksack river in Washington state; *Mirage 24* by Adrienne Elise Tarver, part of her watercolour series of nude women lounging and swimming in tropical environments; and Mask of K̓umugwe’ (Chief of the Sea), an alder and red-cedar-bark mask made around 1880 by the Kwakwaka’wakw Indigenous peoples of the Pacific Northwest coast, whose culture and traditions are centred on the natural environment.

Our Blue Planet is on display at the Seattle Art Museum until 30 May.

Gege Li

RAQIB SHAW

ADRIENNE ELISE TARVER



MASK OF KUMUGWE’ (CHIEF OF THE SEA), CA. 1880 NATIVE AMERICAN

Editor's pick

On the never-ending question of infinity

16 April, p 38

From Ian Dunbar,
Culcheth, Cheshire, UK

In his article, Timothy Revell asks: "Mathematically, infinity is useful, but does it really exist in the physical world?" This question raises issues beyond the nature of infinity, questions about the ontology of mathematics and its relation to physics and the physical.

Our knowledge of arithmetic seems to be at least as secure as that of the physical world. It is therefore hard to see why numbers should be seen as less real than physical objects. Moreover, mathematical physics is full of references to numbers, so the physical and mathematical worlds appear to overlap. Nobel prizewinner Eugene Wigner called this "the unreasonable effectiveness of mathematics in the natural sciences".

From Peter Leach,
Nercwys, Flintshire, UK

Infinity has always been an uplifting, almost spiritual, concept for me, so I was interested to read about the knots mathematicians tie themselves in while trying to define its mathematical nature.

The concept of nothingness is harder for me to live with than infinity. It feels scary, unnatural and dispiriting.

From Philip Welsby, Edinburgh, UK

Mathematics can't address infinity as suggested. That infinity comes in different sizes is a nonsense because infinity isn't a number. Any infinity that can be doubled, or broken down into a great number of smaller numbers, isn't an infinity to begin with.

From Bryn Glover, Kirkby
Malzeard, North Yorkshire, UK

Having grappled with infinity for as long as I can recall, your cover line, "A new answer to the largest question of all", sent me eagerly seeking the article. Alas, I was disappointed.

The big problem, as I see it, lies in attempting to analyse infinity as if it were an actual, tangible mathematical entity – an exceedingly big number. It isn't. Infinity is a convenient concept, in the same way that *i*, or an imaginary number, is a convenient concept. It is a tool invented for a job. It performs its tasks admirably, but it needs to have been eliminated by the end of any calculation, otherwise the conclusion is meaningless.

From David Holtum,
Bathampton, Somerset, UK

Thanks for the very interesting article highlighting some of the difficulties with infinity.

Quite a few mathematicians have problems with the concept of infinite sets and Norman Wildberger at the University of New South Wales has released a number of videos that have elaborated at great length on infinity, the difficulties of real numbers, functions and calculus.

An interesting recent development is the use of "intuitionist mathematics" by physicist Nicolas Gisin to reformulate some of the laws of physics. This rejects the existence of numbers with infinitely many digits. His approach seems to offer hope of closing the gap between relativity and quantum mechanics.

Memories can linger for millennia

16 April, p 12

From Will Kemp, Wagait Beach,
Northern Territory, Australia

In your article about people in what is now Chile who maintained memories of coastal threats for 1000 years, you quote Eugenia Gayo on her belief that people "usually have a short memory" for events like tsunamis, and that maintaining behaviour linked to such memories for 1000 years "is a lot". However, I understand that some Indigenous people in the far north of Australia still maintain memories of land that was submerged by rising sea levels after the last glacial period, many thousands of years ago.

The article states this memory happened "despite not having a system of writing". I'd say people were able to maintain those memories because they weren't written. Oral tradition may be longer lived than written history.

Open-plan office sounds good until reality dawns

16 April, p 44

From Ron Dippold,
San Diego, California, US

You reported on preferences for open-plan spaces in your look at the psychology of design, often based on virtual reality experiments. Yes, most people would rather work in a brightly lit open space, but only up to a point. In reality, real-world studies show that when it comes to offices, working in an open-plan space with more than half a dozen other people is a miserable experience.

You are interrupted by noise. Constant movement in your peripheral vision is exhausting. You are often hot-desking. Sales people bellow all day. Everyone else gets noise-cancelling headsets and pretends nothing around them exists, so communication and satisfaction decrease.

So hurrah for the dingy closet workspace! I went from an open-plan office to a bedroom for the pandemic. Many workplace experts seemed to think it would plunge me into depression. Instead, it was a huge productivity and morale boost. I could open a window for fresh air and focus on getting work done.

From Trevor Jones,
Sheringham, Norfolk, UK

The article "Better by design" at last presents a science-based approach that takes architecture and interior design seriously. I particularly valued the "habitat theory" of open-plan living.

I have recently introduced wood-frame glass doors into the ground-floor living areas of my dual-aspect house after watching a video of a Frank Lloyd Wright house in the Prairie (savannah-like?) style. I find this to be more secure and comforting, as there are now across-vistas to the front and back gardens. Worth every penny, as better design often is.

Amazon destruction is just so worrying

9 April, p 20

From John Neimer,
Stoborough, Dorset, UK

You report the truly frightening destruction of the Amazon rainforest, which seems to be aided by the actions of Brazil's president. Perhaps environmental protest groups in the UK, like Extinction Rebellion, could make an impression by blockading the Brazilian embassy instead of disrupting ordinary citizens' lives.

From Geoff Harding,
Sydney, Australia

A strategy to halt the deforestation of the Amazon is to encourage a blanket ban on the import of all products sourced from the Amazon. This could be done via the COP27 climate summit.

This would have the additional benefit of promoting a drastic reduction in beef cattle ranching, which would lead to significant greenhouse gas reduction. In compensation, farmers could be paid to reforest their land for carbon offsetting. ▮

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A bad omen?

The story of a 1960s hunt for people who claimed they had premonitions is beautifully written, but goes too easy on the pseudoscience, says **James McConnachie**

Book
The Premonitions Bureau
Sam Knight
Faber

IN OCTOBER 1966, around the time a colliery spoil heap in Aberfan in Wales collapsed, burying a school and homes and killing 116 children and 28 adults, an English psychiatrist called John Barker was working on a book about people who appeared to have scared themselves to death.

In some ways, it was a precursor to the work of writers such as Oliver Sacks: Barker was boldly but thoughtfully exploring the odder reaches of the psyche. In other ways, however, his research was sensationalist and foolish – Barker was also a member of the Society for Psychical Research and he had suggested that people could become aware of the moment of their death. By telepathy, perhaps.

In the aftermath of the Aberfan disaster, Barker heard that a boy who had escaped the wave of coal slurry had later died of shock. Barker drove 160 kilometres from a psychiatric hospital where he was a consultant to investigate. But while touring Aberfan, he heard stories of forebodings and warnings, and he had a new idea.

Within a week, in collaboration with Peter Fairley, the *Evening Standard*'s science journalist, he was inviting the newspaper's readers to contact him with their "dreams and forebodings". These would be recorded and, in the event of ensuing disaster, verified. This was the "premonitions bureau", and its story (and Barker's) is the subject of a book by journalist Sam Knight.

Barker was certainly an interesting man. Intellectually ambitious, he researched Munchausen's syndrome and experimented with aversion therapy, claiming to have cured a man of desire for an extramarital affair by administering 70-volt electric shocks. He was a pioneer of longboard surfing. And he kept a crystal ball on his desk.

In the 15 months it existed, the bureau collected 723 predictions, of which 18 were recorded as "hits", with 12 coming from just two correspondents. One was a London music teacher, Kathy Middleton. She saw pictures, with words flashing as if in neon lights. The other "human seismometer", as Fairley put it, was a switchboard operator called Alan Hencher, who worked at the Post Office. His visions were accompanied by distress and headaches.

In one "major hit" for the bureau, Hencher predicted a plane crash involving 123 people. Nine days later, a plane came down near Nicosia in Cyprus, killing 126 people, 124 of them on impact.

> **"While touring Aberfan, John Barker heard stories of forebodings and warnings, and he had a new idea"**

In another, Middleton wrote to Barker detailing a vision of a petrified astronaut. Earlier that day – although it wasn't reported until later – Vladimir Komarov's Soyuz 1 capsule had crash-landed in Russia, burning him to death.

MARIO DE BIASI/MONDADORI VIA GETTY IMAGES

The Aberfan disaster in Wales was caused by a colliery spoil tip collapse

Knight finds that Barker could be "credulous, or laconic; doubtful, yet insinuating". Something similar is true of Knight. Now a staff writer at *The New Yorker*, his non-fiction heroes include sophisticated literary storytellers such as W. G. Sebald and Joan Didion. He likes jump cuts, internal resonances and leaving things unstated.

Take the section where he segues from a discussion of entropy to a tragic outbreak of foot-and-mouth disease in England and then to a campaign to shut Victorian-era asylums – by a woman who dreamed of the winning horses in the Epsom Derby.

Or another where he moves from the origin of the word embolism to the nocebo effect and Sweden's *uppgivenhetssyndrom* (resignation syndrome), a condition in which refugee children appear to retreat into near-comas of hopelessness.

With such manoeuvres, Knight builds a subtle, allusive study of his subject, and his evocation of the frowsty yet aspirational mid-1960s England feels just right. But it is Barker who dominates the book, with his "contained, quietly belligerent energy", and Knight treats him with generosity, and delivers a great deal of pathos.

Too much generosity and too much pathos, because premonitions aren't true. If you deal in them, you are deluded or a charlatan. Barker was mostly the former. Knight, I am sure, is neither – but he still allows the possibility to play, as a kind of mood music. And for all that this is a compelling, beautifully written book, it feels like bad faith. ▮

James McConnachie is a writer and reviewer, and editor of *The Author*, the journal of the Society of Authors

The other battle

Bill Gates's latest book is full of good ideas for preventing future pandemics. But he omits a key issue, says **Adam Vaughan**

Book

How to Prevent the Next Pandemic

Bill Gates

Allen Lane

NOT content with writing a handbook on tackling climate change, Bill Gates has turned his attention to another of the world's biggest problems: stopping the next pandemic. While covid-19 is still with us, many people are acting as if it isn't. In this rush to "normality", the entrepreneur and philanthropist worries that we may not learn the lessons we need to avoid a repeat. "We're all eager to return to the way things were before, but there is one thing we cannot afford to go back to – our complacency about pandemics," he writes in *How to Prevent the Next Pandemic*.

Gates is good at guiding readers through his blueprint for the technological, economic and regulatory fixes to stop the next pathogen from causing global havoc, never assuming too much knowledge.

Much of his prescription for pandemic prevention is hard to argue with. Who doesn't want more investment in public health systems globally, better surveillance, quicker treatments and vaccines? Other ideas are sensible, too, such as smarter and more frequent pandemic simulation exercises.

More debatable is his proposal for a global pandemic agency, the Global Epidemic Response and Mobilization (GERM) team, with $1 billion annual funding. Gates says it would be managed by the World Health Organization, but never explains why a new layer of bureaucracy is better than just beefing up the WHO.

Nor does he spell out how GERM would escape the same nationally self-interested headwinds the WHO faces, such as the US cutting funding in 2020, or China's decision in 2021 to block more investigation into the origins of covid-19.

ANDY LYONS/GETTY IMAGES

The covid-19 pandemic led to extensive school closures and online teaching

Gates admits he was too pessimistic about how quickly a covid-19 vaccine could be available globally (as late as April 2024, he said), and explains why he now thinks vaccines could be ready in six months next time (mRNA is part of the answer).

He comes out against future school closures, assuming children aren't more vulnerable to the next disease. And while he is for contact tracing, he is sceptical about apps for it because of low take-up. Ventilation gets an enthusiastic thumbs up, as do cheap and effective masks. As one public health expert told him, the book would be very short "if everyone would just wear masks".

His book is punctuated with powerful examples from personal experience. He recounts watching a minimally invasive autopsy of a baby boy in Soweto, South Africa, in an otherwise dry passage about ways to understand causes of death in low-income countries to improve outbreak monitoring. He is often self-aware ("yes, I am a technophile"), but still slips into occasional self-promotion (why mention he had known White House chief medical adviser Anthony Fauci for years before covid-19?).

There are other things to grumble about. The minutiae of regulation and policy that Gates explores are important, but often make for dull reading. While many of his ideas and principles are good (we don't need to choose between preventing pandemics and improving global health), they are often so obvious that you question the need for a whole book.

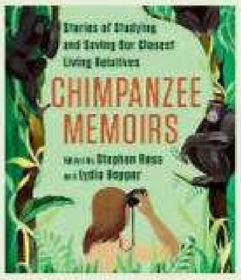
Perhaps the biggest flaw is one of omission. The issue of minimising the risk of disease spillover in the first place, by addressing wildlife markets or extractive industries in wild places, is missing. Yet an off-topic chapter about covid-19 accelerating the process of digitisation is tacked on at the end.

This handbook isn't as successful as Gates's climate guide, but it is welcome. And it couldn't be more timely, with thousands still dying daily. As he writes, "once covid is no longer an acute threat, don't forget about what it has done". ■

Don't miss

Visit

In the Air at London's Wellcome Collection traces concerns about air quality back to the 17th century, revealing how the air we breathe influences well-being. The exhibition opens on 19 May.


Stories of Studying and Saving Our Closest Living Relatives
CHIMPANZEE MEMOIRS
Edited by Stephen Ross and Lydia Hopper

Read

Chimpanzee Memoirs, edited by Stephen Ross and Lydia Hopper, tells the personal stories of chimpanzee experts and shows the effort that has gone into understanding and saving our chimp relatives in forests, sanctuaries and zoos.

Watch

How the science of dogs changed the science of life captivates zoologist Jules Howard. His talk, which streams from London's Royal Institution on 12 May at 7pm BST, explores what we know about dogs.

HORNIMAN MUSEUM & GARDENS; SHUTTERSTOCK/ENNA8982

The sci-fi column

Identity crisis Shades of dark romanticism and late 19th-century social savagery haunt two wild new books, which are united in their exploration of how unreliably memories construct our identity, says **Sally Adee**

Sally Adee is a technology and science writer based in London. Follow her on Twitter @sally_adee

Books

Eversion
Alastair Reynolds
Gollancz

Glitterati
Oliver Langmead
Titan

Sally also recommends…

Book
The This
Adam Roberts
Gollancz

Memory also plays a starring role in The This *by Adam Roberts, but the utility of an individual's identity itself is called into question in this mash-up of the sum of Nick Bostrom's worst fears in* Superintelligence *and the alien weirdness of Arthur C. Clarke's* Childhood's End.

ONURDONGEL/GETTY IMAGES

Memories are subject to the same pressures as fashion in *Glitterati*

YOUR autobiographical memory can't be trusted, and science has determined that this isn't a bug, but a feature. The remembered stories from which we braid our identity bend and swerve to serve the narrative needs of our circumstances because our minds happily trade veracity for coherence and narrative. This strange space between recollection and construction is explored in two mesmerising books out this month.

Eversion by Alastair Reynolds concerns itself with how this constant process of layering and recasting can create meaning and purpose in the most desolate circumstances. The story starts on a ship dodging icebergs in the North Sea during the 17th century, and unfolds into a virtuoso genre-hopping puzzle.

It isn't every day you get to experience a perfect collision of the Romantic macabre of Edgar Allan Poe and H. P. Lovecraft with *The Usual Suspects* and *2001: A Space Odyssey*. So much of the book's joy is working out which bits are real and which are misdirection on the way to unlocking the final mystery. Trust me, you don't want this spoiled by more plot details.

It is no spoiler to say that Reynolds shows how such stories can be moulded to make us better humans. But memories can also be weaponised to keep our identities in stupefied thrall to capitalism, and this darker aspect gets an ample airing in Oliver Langmead's *Glitterati*.

> **"*Glitterati* starts like puff pastry, stuffed with buffoonery, but it ends like a shot of *Black Mirror*"**

The star of this speculative satire is Simone. He is a fashionite, a rarefied type of super influencer whose every whim is lavishly catered for and documented by magazines read only by fashionites. For example, during a brief hospitalisation, he spies a regular proletarian gown among the *haute couture* medical gowns available to him. He complains and the item is summarily burned.

Simone and his fabulous friends and enemies are suspended in a vicious, never-ending battle for status, fought through clothes, make-up and accessories, sometimes leaving literal fashion victims in their wake. This sense of dangerously pointy high stakes beneath the ruffles and froth recalls writers like Edith Wharton, whose stories dissect the mores of the very rich who lived and schemed during the so-called Gilded Age of the 19th-century US.

Beyond a deft, wicked skewering of influencer culture, Langmead inhabits his protagonists' fetishistic delight with the material world. His deliciously sensory prose puts you inside that colossal closet, running your fingers through the gossamer folds of a spider-silk gown.

Glitterati starts like puff pastry, a comedy of manners stuffed with buffoonery and characters whose trivial, self-inflicted miseries you can chortle at with abandon. But it ends like a shot of *Black Mirror*.

Simone's lifestyle isn't without costs. Along with the right clothes, he needs the right memories. And that is when a darker reality emerges, showing why these fluffy idiots can't care about anything more than matching their outrageously expensive outfits to their false eyelashes.

At this point, it becomes clear that rather than being privileged scions, people like Simone are just pretty cogs in a vast apparatus that grinds humanity into capital. The reader begins to sympathise and have a stake in Simone's ability to escape – and perhaps also starts to wonder which forces bend our own (flawed) memories. ▮

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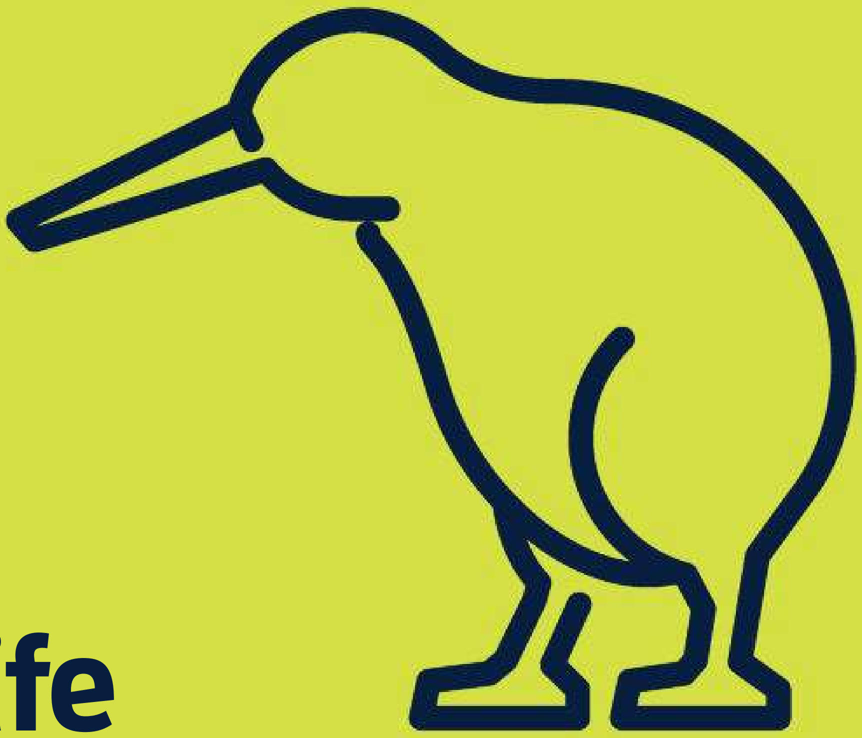

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STUART MCREATH

A seismic mystery

Deep inside Earth are two vast geological anomalies of unknown origin. Planetary scientists are on a mission to explain these mysterious blobs, as **Robin George Andrews** discovers

OUR planet is like a bad cake in a cosmic baking contest. On inspection of the first slice, the judges might say its layering is quite neat. The crunchy crust sits on a solid-but-squidgy mantle, which wraps around a gooey outer core. But cut another slice and they will soon see that something has gone awry. Looming inside the neat layers are two giant, messy lumps.

These two blobs are colossal. They are the size of continents, covering almost a third of the boundary between the core and the mantle. We also know that they are hotter than their surroundings. But everything else about these blobs is mysterious, from what they are made of and where they came from to how they affect our planet today.

The quest to understand them has so far verged on the quixotic. Geologists and planetary scientists are pursuing it with vigour, however, because the blobs are likely to be guarding some serious secrets. We are scrambling to get a better picture of these shadowy underworld titans, not least how ancient they are.

That is important because if they turn out to be geologically youthful, it would suggest we are living through a special epoch. There must be something particularly strange going on down there, to produce such giant oddities. Whereas "if these things are truly ancient", says Sujoy Mukhopadhyay at the University of California, Davis, "it tells us something about how our planet formed". And they might even surprise us with an answer to a bigger question, one that goes beyond parochial concerns about our own planet.

Since the late 19th century, geologists have used vibrations called seismic waves, normally generated by earthquakes, to map the interior of our planet. These waves move slowly in less dense and rigid rock, but faster through more tightly packed matter. After studying their speed in countless rock types, geoscientists sent seismic waves through Earth to see the composition of its internal structure: a solid inner core, surrounded by a liquid outer core, which sloshes molten iron and nickel around to generate its magnetic field. On top of this is the mostly solid mantle, the bulk of Earth's interior. Capping all this is the crust, an amalgam of rocks that have been erupted, broken up, squashed together and pulled apart. This is what you learned about at school.

But what you may not know is that, in the 1980s, seismic waves hit on something odd: two giant clumps inside the planet's mantle, making up about 8 per cent of the mantle's volume. These lumps sit on top of the liquid core, one below the Pacific, one beneath Africa. As wide as ocean basins, they also seem to rise almost 1000 kilometres vertically, into the mantle. They are uneven and misshapen, like the waxy blobs of a lava lamp. But right from the get-go, the questions of what they are doing there, and how they got there, have confounded Earth scientists.

It is even hard to know what to call them. When seismic waves hit the blobs, they slow down. This earned them the name "large low-shear-velocity provinces", a clumsy collection of words. "It's not an acronym you can easily say," says Paul Byrne, a planetary scientist at Washington University in St Louis, Missouri. Some call them superplumes. Byrne insists "blob is fine".

Most of what we know about these blobs is through seismology, but seismology has its flaws. Temperature changes the density and rigidity of a rock, but so does its composition. "It's really hard to tell the difference between ›

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Shaping Earth

Two vast blobs of anomalous material in Earth's mantle (see main story) are, geologically speaking, alive. This layer of our planet is populated by towering streaks of superheated material that rise to inflict prolonged, island-making, continent-tearing and occasionally climate-changing volcanism on the surface.

Plume-driven volcanism is unlike any other. It has created chains of islands like the Hawaiian archipelago, home to by far the largest volcanoes on the planet. It played a key role in the dismantling of supercontinents and the creation of ocean basins. And it even contributed to the chaos that unfolded 65 million years ago, unleashing climate-changing volcanic gases while the world reeled from a major asteroid impact.

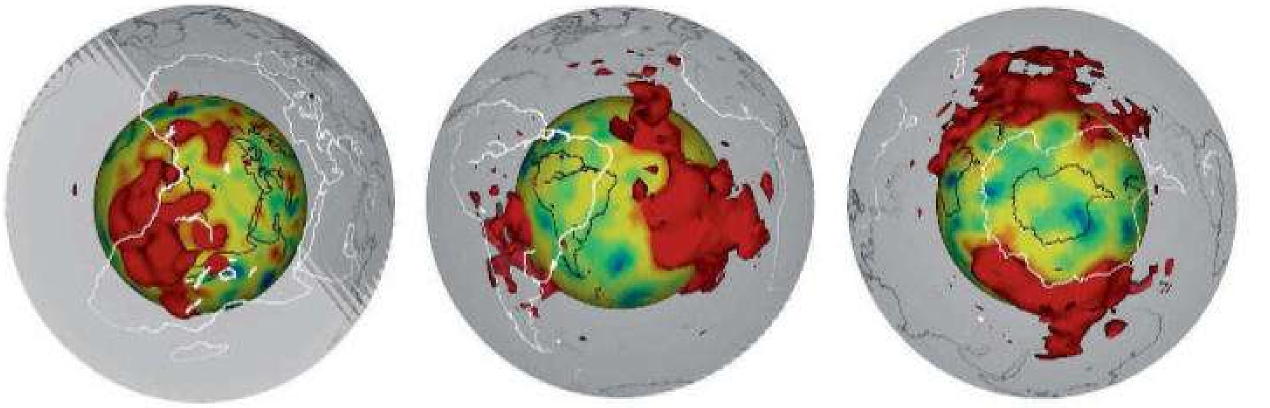
Although some seem to stand alone, most of these entities, named mantle plumes, appear to sprout from the two blobs. But the way they do this is subject to debate. They might rise up as one continual fountain, or they could appear as many little blobs that together give the illusion of one continuous plume. For now, the main investigation is into where they came from. "Until we know what the blobs are, it seems a bit premature to attribute them to any causal mechanism," says Paul Byrne at Washington University in St Louis, Missouri.

the two," says Harriet Lau, a geophysicist at the University of California, Berkeley. Most agree that the blobs are probably hotter than the surrounding mantle, but it is hard to tell if they are made of the same stuff, with lots of iron in them, or if they are packed with other minerals.

Rise and fall

The simplest explanation is that they are made of the same material as the mantle, and are just hotter. If so, their presence may be a result of the disintegration of Pangaea, Earth's most recent supercontinent, which formed around 330 million years ago and started breaking up around 200 million years ago. Continents are part of the planet's outer shell, made of crust and some upper material in the mantle. As Pangaea broke into tectonic jigsaw pieces, prominent subduction zones – deep wounds that allow one tectonic plate to descend beneath another – opened up. For the past 250 million years, defunct chunks of tectonic plates, called slabs, have been descending into the lower mantle. Since the insides of our planet are hotter, the blobs might simply be the warm spots on the core-mantle boundary that aren't receiving any of this cooler falling material.

Then again, the simplest explanation isn't always the correct one. There is also a chance these blobs aren't just hotter, but are also made of different stuff to the rest of the mantle. If so, where they came from is a mystery. And the key to solving the mystery lies in their density, which determines what rises and falls, and gives clues about temperature and chemical composition. "Density is kind of the holy grail in this debate," says Paula Koelemeijer, a seismologist at Royal Holloway, University of London.



Two giant blobs (red) sit inside Earth, below the Pacific and parts of Africa

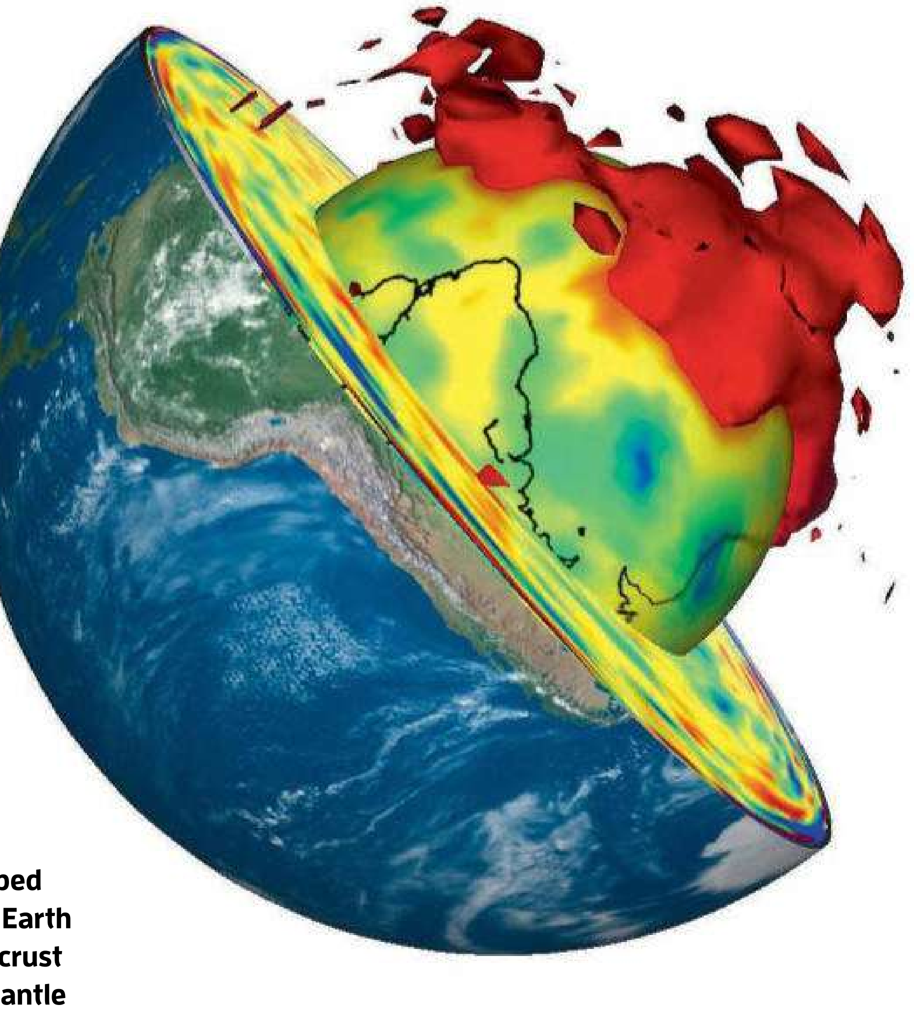
Working separately, Lau and Koelemeijer have both been trying to figure how dense these blobs are. In 2017, using GPS sensors to measure tidal changes to the shape of the crust caused by the blobs, Lau and her colleagues estimated the blobs to be fairly dense. But that same year, Koelemeijer and her colleagues used a type of seismic wave sensitive to deep mantle structures, to study where the blobs sit in relation to the core. They were always elevated above the rest of the core, hinting that they were less dense than the surroundings.

The two approaches "were showing us conflicting results", says Koelemeijer. To crack the case, the researchers decided to team up. Early results from their new work indicating that the blobs may be mostly light – perhaps bundles of hot, buoyant mantle plumes – but with dense plant-like roots. But until the results are published, they don't want to speculate about what this could mean for the blobs' origins.

Another important conundrum is the age of these blobs. Scientists examined lava spewed by oceanic volcanoes powered by the blobs (see "Shaping Earth", left), finding odd chemistry. Some of this volcanic material seems like it "hasn't ever erupted at the surface of the planet", says Lau. This includes radioactive elements dating back to the first 50 to 100 million years of Earth's life, stuff you won't find in younger rocks. "That's a very strong argument to say there's something really ancient down there," says Mukhopadhyay.

If so, that would go against the idea that plate tectonics caused the blobs. Plate tectonics began at least 3 billion years ago, but we don't know exactly when it started. If the blob matter is truly primordial, even older than the advent of plate tectonics, then where else could it have come from? One option is that this material crystallised deep within the molten soup that was the very young Earth, remaining there since.

A more intriguing suggestion, which has been gaining interest in recent years, is that the



Strangely shaped entities inside Earth rise out of the crust and into the mantle

blobs come from elsewhere in the solar system.

Around 4.5 billion years ago, when Earth was just an infant, an object the size of Mars, known as Theia, is thought to have slammed into the planet. This giant impact sent molten matter screaming into orbit around our magma-covered world, material that coalesced to form the moon. This idea of how the moon formed has been around since the 1970s, and remains the leading hypothesis. In recent years, however, some have taken it further, wondering if Theia may also be the origin of the blobs. Segments of Theia's corpse could have been preserved on the fringes of Earth's core for the past 4.5 billion years.

If that's right, it would solve the origins of the Earth blobs and settle the debate over how the moon formed in one fell swoop. Except that is a tricky thing to prove. For one, Theia has been destroyed, so we can't take samples to compare with the lava created by the blobs' mantle plumes. Another issue arises when trying to virtually reproduce the giant, primordial impact. Chemical analyses of lunar material scooped up during the Apollo era suggest that the moon is mostly made of Earth material, but simulations of the giant primordial impact create a moon mostly made from Theia. A recent study suggested you get something geologically closer to the real moon if Theia hit a magma-ocean-covered Earth, but it still isn't a perfect replication of reality.

> **"There could be something really ancient down there"**

There are various ways we could yet get a better understanding. If Earth blobs truly are primordial, then ancient radioactive elements would give off a unique neutrino signature that, hypothetically, could be detected at the planet's surface. But that would need the right sort of detectors placed at the perfect spots, and we aren't there yet.

Most scientists hope to do more with the tools they already have – seismology, chief among them. Most seismometers, the devices that detect seismic waves, are on land, which makes up less than a third of Earth's surface area. The oceans, on the other hand, are "one massive blind spot that global seismology is yet to really improve upon", says Lau. Floating seismometers, or vast arrays of sea-floor seismometers that can peer into the planet in considerable detail, are starting to fix that. This sort of research is showing our pair of mystery objects "not as two massive blobs, necessarily", says Koelemeijer, "but much patchier with more details."

The plot thickened last year when Qian Yuan, a doctoral student at Arizona State University, presented intriguing new results at the Lunar and Planetary Science Conference, held online. According to a combination of his colleagues' prior work and Yuan's computer simulations, after Theia's collision with our planet 4.5 billion years ago, much of the upper segment of Earth was liquefied, and Theia was largely obliterated. About 20 per cent of Theia's mantle punched through to Earth's lower mantle, a solid layer that for the most part didn't join in with the sloshing molten world above. Yuan's argument is that there, below that shield, Theia's mantle shards remain, surviving to this very day.

That may sound far-fetched, but it would tally with the hints of primordial matter in some of the lava driven onto the planet's surface by the blobs' plumes. And there might be ways to test Yuan's hypothesis.

According to Yuan, samples of the moon's crust offer additional clues. A team of his colleagues has studied the chemistry of these rocks, and found that they suggest the lunar mantle – a stand-in for Theia's mantle – has a preponderance of dense iron oxide. That suggests the blobs are denser than Earth's mantle.

If so, that may explain why they still exist today: instead of being swept up by the mantle's currents and blended into it, their high density let them sink to the base of the mantle and become stubbornly stuck there, to this day. Subducting plates may be influencing the location and composition of the blobs today, but perhaps Theia gave birth to them. That would have been a sight to behold, says Yuan. "It's beyond my imagination." ▮

Robin George Andrews is a freelance writer and author of *Super Volcanoes: What they reveal about Earth and the worlds beyond*

LEFT & ABOVE: DR. HIROKI ICHIKAWA (HTTP://DAGIK.ORG/MISC/GST/INDEX.HTML)

"Humans police the expression of sex and gender much more than other primates do"

Apes give us a better understanding of gender behaviour and identity in humans, says **Frans de Waal**. Once we start hunting for variation, it may turn out to be more common than we thought, he tells Rowan Hooper

WHERE once we thought of ape behaviour only in terms of sex and war, we now understand that our closest relatives live a much more nuanced life. A huge part of that understanding comes from the work of primatologist Frans de Waal, a professor of psychology at Emory University in Atlanta, Georgia. Over the past five decades, he has shown that cooperation is at least as important as competition in explaining primate behaviour and society. His work has revealed that the great apes might fight, but they also reconcile their differences. They have a capacity for empathy and a concept of fairness that de Waal proposes is the foundation of the human moral compass. He believes that chimps, bonobos and humans are simply different types of ape and that empathetic and cooperative behaviours are continuous between these species. Now, he has turned his attention to gender and identity in his new book *Different: What apes can teach us about gender*. We spoke to de Waal to find out what he has learned.

Rowan Hooper: You are well known for writing about the inner lives of chimpanzees and bonobos, but your new book is a bit different, because it discusses gender roles, gender identity and biological sex differences in both apes and us. What do we mean by gender in non-human primates?

Frans de Waal: Well, some people insist that we have genders and chimps and bonobos have sexes, and that is the end of the discussion. I think that is nonsense. Gender as a concept exists mainly because we are a sexually reproducing species. Sex is predominantly binary – male and female – plus a small percentage of people who are intersex. Imagine if we reproduced by cloning and were all basically identical. No one would have even conceived of the concept of gender.

Aspects of gender, such as social roles and gendered behaviour, represent the cultural side of biological sex. Gender in this respect is not male or female, but rather masculine, feminine and everything in between. It is a much more fluid concept than biological sex.

This concept of gender roles and behaviour may also apply to apes, because they are cultural beings, too. They develop slowly and are adults by 16 years of age, so there is an enormous amount of learning that goes into their behaviour, which includes their sex-typical behaviour. Like our children, the young pick up aspects of their gender roles from the adults around them.

In your book, you say that while gender roles and gendered behaviour can be influenced by culture, gender identity seems to arise from within. You write about a chimp called Donna who seems to exemplify this. Can you tell us about her?

Donna, who is biologically female, is very masculine in her appearance and her behaviour – and unlike the majority of female chimps, she likes to hang out with the males. I do not know how she identifies and I can't ask her, but she looks like a male and acts like a male most of the time.

You also have biological males who are big, but are not interested in being high-ranking. They avoid confrontations. They can be well accepted in the group, but accepted as a male who is not involved in male politics. So we have this variability in individuals. Few individuals act like Donna, and few males act non-typically, but it is important for us to recognise that science hasn't been looking into the issue of how individuals express sex-typical behaviour. Once we start explicitly hunting for it, our perceptions may change and gender non-conforming behaviour in primates may turn out to be more common than we thought.

What we might call gender-stereotyped play is seen in young primates. There are reports of young female chimps in captivity playing with dolls, and some in the wild using a wooden log as a doll and even building a nest to put it in. Male chimps, when given a choice of toys, tend to play with toy trucks and trains. What is going on here?

With the males, people have speculated that it is because these are movable objects and males are more physically active in their play. With ›

NABIL NEZZAR

FIONA ROGERS/NATUREPL.COM

Male chimps avoid attacking the offspring of females they have had sex with

females, it is easier to explain: they have a lifetime of maternal care for infants in front of them, and picking up a doll or a log in the forest and holding it like an infant is a way of training themselves. And they imitate their own mum.

It seems as if you are saying that there are certain behaviours that may be influenced by biological sex.

There are certain sex differences that shine through the gender differences. It helps us see that you cannot get around biology. So, for example, males tend to be more physically violent than females. This is true for all the apes that I know and is true for all human societies that we know, so that is a behaviour that is heavily influenced by biology.

However, I would never argue that a biological predisposition towards a certain behaviour means that you have to accept it – we can ask "how do we work towards a different behaviour?"

How can studying primates help us understand more about human sex differences?

It can help show us when our assumptions are wrong – sometimes we assume sex differences that aren't there. For example, it is often assumed that women are less competitive, less hierarchical, less good at being leaders. But all social mammals and birds that I know of have female hierarchies and alpha females. The term "pecking order", for instance, comes from hens, not roosters. In comparison with other primates, it doesn't hold up that women cannot be leaders.

It's the same with the idea that men are not nurturing, which is often assumed – it doesn't really fit with the other primates. It is true that male chimps and bonobos don't show much infant care, but if, for example, an orphaned youngster is begging for attention, the males are perfectly capable of caring for them and may adopt the youngster, sometimes for years.

We touched upon gender identity with Donna. What can primates teach us about that?

Gender identity is intrinsic: it expresses itself very early in life, usually before puberty, and is seemingly irreversible. We have evidence that human gender identity is detectable in the brain. So, unlike gender roles and behaviour, gender identity is not a social construct; it is part of who we are, and this applies to everyone. By studying other species, we can learn about the variability in gender-typical behaviour. There is so little that we know because scientists have, like society at large, overlooked individual variability. We have emphasised the typical expression and downplayed the diversity.

What we will no doubt learn is that other primates tolerate variability a lot better than human society. This is an important lesson: human society tries to monitor and police the expression of sex and gender identity and roles to a much greater degree than other primate societies do.

Bonobos are famously very sexual, having sex with each other all the time – males with males, females with females and males with females. But what kind of variation in sexual preference do we see in chimps?

Bonobos are perfectly bisexual. But in other species, too, we see quite a bit of homosexual behaviour, and some individuals are more inclined to it than others. Biologists are very used to this kind of variability. We understand that no two trees are alike, even if they belong to the same species and grow in the same forest. But, somehow, human society is not happy with variability. We hear things like: "Why are you not acting like a man?" We get upset by variation, even though we should accept that everyone is different.

Even in animals, we don't talk about variability in sexuality that much.

There is a certain shyness about sex. Violence and dominance and territoriality, no problem. But not sex and eroticism – scientists shy away from talking about this. I notice that when I talk about the bonobo clitoris, scientists get nervous. I always think that is very unfortunate.

It surprises me that scientists are still effectively behaving like the Victorians.

Yeah, but we have a long history of denying female sexuality. You know, the idea that females had a passive sexuality – that goes back to Freud and all sorts of other people who denied female sexuality. As a result, bonobos were ignored because their behaviour makes scientists uncomfortable and doesn't conform to the dominant narratives in anthropology that stress male affairs, such as hunting and warfare.

Studying ape behaviour is changing our thinking in this respect. You talk about how it helps form

a feminist Darwinism – tell us about that.
The first goal of Darwinian feminism is to pay attention to the female. If you look at books about human evolution, they are always about male qualities like warfare, territoriality and hunting, and there is very little discussion about what the women were doing in all that time. Some have said that the fittest individuals in our lineage were the men – as if the women were just dragged along in the evolution of the beautiful human male. Pay attention to the females and then you get to understand things like female choice and female sexuality.

The anthropologist Sarah Hrdy paid attention to why female chimps have so much sex, not just with one male but with multiple males. She realised that if infanticide is a big risk, then having sex with lots of males may help you because males won't attack your offspring. Males don't know about paternity, but seem to avoid attacking offspring of females they have had sex with. And if that is their rule, then it is a perfectly good strategy for the females to have sex with a lot of males – a female chimp who is having sex with a lot of males is protecting herself.

Do we know why chimps evolved down a male-dominant, aggressive route and bonobos became peaceful and sex-loving, with high-ranking females? Humans seem to be somewhere in the middle.

> "When I talk about the bonobo clitoris, scientists get nervous"

There is speculation that bonobos lived in an environment where they had no gorillas, so they didn't need to compete with them for the ground vegetation, and that they maybe had a richer forest. More food around allows more individuals to travel together, as they don't need to spread out to find enough food. This advantages the females, as they have a strong tendency to defend each other against males, and being together allows them to do this collectively.

So it is thought that the ecology of the bonobo allows closer female relationships compared with that of the chimpanzee. That may be one reason why female bonobos have taken the dominant role. Chimps in West Africa are more bonobo-like in the sense that they travel more together and the balance of power between male and female has shifted somewhat towards the female. There is more female leadership visible and less sexual coercion.

ANUP SHAH/NATUREPL.COM

Chimpanzees can become more peaceful in plentiful environments

If you look at the recent history of primatology, we have Jane Goodall's work on tool use, Toshisada Nishida's work on cooperation and your work on empathy and the inner lives of primates. They all seem to be undoing patriarchal assumptions of what was happening.
Yeah. [The discredited 20th-century British zoologist] Solly Zuckerman was largely responsible for those assumptions. People still often believe that, in primates, the male is the boss. The male decides. The females are basically the slaves of the male. What kind of nonsense is that! It comes from a management mistake made by Zuckerman years ago at London Zoo as a result of randomly throwing male and female hamadryas baboons together in an enclosure. In the wild, these primates live in groups of one male and several females, but the zoo put nearly 100 males together with a handful of females. It became a bloodbath. Then he, and others after him, presented this kind of behaviour as representing the natural order in primate society.

Are you prepared for any controversy over your book?
I thought while writing it that the biggest objection could come from those who deny any biological influence on gender identity or gendered behaviour, and have elevated gender to a purely cultural thing. We can try to remove biological sex from the gender concept, but we will never fully succeed. Sex versus gender is like nature versus nurture – we know that the two are intertwined and should always be discussed together, as neither can do anything on their own. There is no behaviour that is pure nature, without environmental influences, and no behaviour that is pure nurture, without biological influences.

But, in retrospect, I think my book is more likely to upset people who have the traditional view of just two genders and two sexes. ∎

Rowan Hooper is podcast editor at *New Scientist*. His latest book is *How to Spend a Trillion Dollars*

Obesity blockers

A new class of drug promises to help people lose huge amounts of weight and may even prevent obesity. Will these medications live up to the hype, asks **Sara Novak**

For as long as Kimrey Rhinehardt can remember, she has been trying to lose weight. The keto and paleo diets seemed to work… for a while. But when the weight came off, her emotional eating and sugar cravings ruined her efforts.

Rhinehardt's battle to control her weight has been frustrating, but for the management consultant from Pittsboro, North Carolina, it is also dangerous. She has high cholesterol, asthma and a family history of breast cancer. Her weight raises the likelihood she will die from one of these risk factors.

Then, six months ago, a doctor prescribed her weekly injections of a new kind of medication, and everything changed. She lost more than 27 kilograms and her body mass index (BMI) dropped from 41 – considered severely obese – to 32, just over the threshold for obesity. The drug even changed her perspective on food. Rhinehardt isn't interested in many of the unhealthy snacks she used to love. "Cravings for sugar and bread don't exist any more," she says.

This new drug, semaglutide, marketed as Wegovy in the US, was approved last year by the US Food and Drug Administration (FDA). For Rhinehardt, it has been the boost she needed to finally lose the weight she has struggled with for decades. But for some in the medical profession, the hope is that the drug might revolutionise our fight against one of the most prevalent and lethal health problems in much of the world. Not only could it help treat obesity in people finding it hard to lose weight, but it might even be used to prevent the condition in the first place.

Obesity is a chronic health issue that puts people at risk for other chronic conditions, including cancer, diabetes, heart disease and sleep apnoea. It is also the most common health condition in both the UK and US: 28 and 42 per cent of their adult populations, respectively, are obese. In 2016, when the latest figures from the World Health Organization (WHO) were made available, 13 per cent of adults globally were obese, a figure that had nearly tripled since 1975. Most of the world's population now live in countries where being obese or overweight kills more people than being underweight.

Obesity on this scale may be a modern malady, but the promises of quick fixes for losing weight have been with us for centuries. In the 1800s, soap and arsenic were touted as good options for those wanting to slim down. By the 1930s, dinitrophenol – an organic compound that can cause rapid breathing, a fast heart rate and heavy sweating and can, in some cases, prove fatal – was promoted for weight control. And prior to a US ban in the 1970s, amphetamines became a fashionable means of appetite suppression, despite powerful side effects, including the risk of heart problems.

Even drugs approved by the FDA have flopped. Fen-phen, named after the two appetite-suppressing drugs it contained, fenfluramine and phentermine, was considered the star of diet drugs in the 1990s until it was withdrawn from the market because it caused heart valve defects in as many as a quarter of people taking it. In 2020, another diet drug, lorcaserin, was pulled from sale when it was linked to a range of cancers,

> **"The drug might even be used to prevent obesity in the first place"**

NOSYSTEM IMAGES/GETTY IMAGES

including pancreatic, colorectal and lung.

Despite this chequered past, with obesity rising globally – coupled with the fact that when people do lose weight, they normally put it back on again within a few years – there is still a thirst for medicines that could help.

This is where a hormone called GLP-1 comes in. As food moves from the oesophagus to the gastrointestinal tract, it activates a system of hormones that help control the digestion of food. GLP-1, which is released from the small intestine, is of particular importance. It signals to the pancreas to release insulin, a hormone that allows cells to take up and use additional glucose from the foods we eat, while cutting the amount of the hormone glucagon – also produced in the pancreas – which boosts blood sugar levels. Together, this means fewer sugars are left in the body.

People with type 2 diabetes tend to produce insufficient amounts of GLP-1, which can result in too much glucose in the bloodstream. Semaglutide, however, increases the amount of the hormone circulating the body, helping to bring blood sugar levels under control.

Given these effects on the pancreas, semaglutide was originally approved for diabetes in 2019. But during the diabetes trials, participants also saw significant weight loss. That is because GLP-1 slows gastric emptying, and keeping food in the stomach for longer creates a greater feeling of fullness. The hormone also results in nerve signals being sent to the hypothalamus, a hormone control centre in the brain, telling it to reduce hunger. "Patients benefit because it both decreases the desire to start eating and, when you do eat, you stop sooner because you feel full," says Thomas Wadden at the University of Pennsylvania.

Following these hints that semaglutide might also be useful for those with weight issues, new trials took place with an increased dose to boost weight loss, and the results were dramatic. Almost 2000 people who were obese were given weekly injections of 2.4 milligrams of the drug – more than twice what the participants in the diabetes trial received – or a placebo, and they also undertook lifestyle ›

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Pills vs surgery

In the US, 228,000 weight loss surgeries were done in 2017. The most popular type is sleeve gastrectomy, where three-quarters of the stomach is cut out so the individual can't eat as much. In the two years afterwards, people see a mean weight loss of 20 per cent. Although we don't have long-term data for the weight-loss drug semaglutide (see main story), Thomas Wadden at the University of Pennsylvania says that if people on the drug maintain their weight loss for two years and it is cost effective, they may choose it instead of surgery. It is the first weight-loss drug to show comparable results to surgery.

interventions, such as diet and exercise. Those given the drug lost, on average, around 15 per cent of their body weight during the 68-week trial, compared with 2.4 per cent in the placebo group.

Experts are cautiously impressed by these results, and semaglutide was approved by the FDA in June 2021, the first weight-loss drug to gain such approval since 2014.

As well as working well compared to a placebo and lifestyle changes, it also compares favourably to other available weight-loss drugs, because it targets a hormone in the body, rather than just targeting the brain, says Wadden. Contrave, for example, is a combination of the antidepressant bupropion and the addiction drug naltrexone. It works on the hypothalamus to help regulate appetite, but it doesn't provide the double whammy of satiation on the gut, and people taking it typically lose between 5 and 10 per cent of their body weight. Those taking it also commonly experience dizziness, a dry mouth, insomnia and intense dreams.

Other drugs work by blocking the digestion of fat in the foods you eat, so that about a quarter of it is excreted in your stools rather than being absorbed during digestion. This more primitive method results in around a 5 per cent weight loss and is accompanied by some pretty unpleasant side effects, such as loose stools, oily faeces and incontinence.

With semaglutide, by far the most common issues have been gastrointestinal. Forty-five per cent of trial participants reported nausea and 30 per cent experienced diarrhoea or constipation. Vomiting affected 24 per cent. This can put some people off, says Fatima Stanford at Massachusetts General Hospital. "When you hear that 45 per cent of patients will have nausea, that is high. Some of my patients fear having it and won't try the medications as a result." Another 5 per cent developed gallstones due to the rapid nature of the weight loss, requiring surgery in some cases.

For the most part, however, doctors have been able to mitigate side effects by starting at a low dose and slowly increasing it as the body develops a tolerance and symptoms subside, says Patrick O'Neil, director of the Weight Management Center at the Medical University of South Carolina. Only about 3 per cent of participants dropped out of the trial due to side effects. Still, we don't yet have data on any long-term effects.

Lifetime commitment

The hope is that semaglutide could help people like Rhinehardt finally reach a healthier weight and, more importantly, keep it off. In fact, the drug's approval seems to be accompanying a shift in the way that obesity is being treated, at least in the US, with the FDA categorising weight-loss drugs differently, says Robert Kushner, a endocrinologist at Northwestern University in Illinois.

Semaglutide, for example, is in a new group of drugs called anti-obesity medications that are approved by the FDA for chronic weight management, an acknowledgement that the issue with obesity often isn't just losing the weight, but keeping it off. "Those of us that work in this field think of obesity as not just about losing weight, but about how we treat the disease of obesity and all the metabolic and health conditions that are associated with it," says Kushner. Some people may need help keeping the weight off for the rest of their lives.

These drugs are approved for both weight loss and weight maintenance, which means they need to be thought of as long-term solutions for a chronic relapsing condition, says Kushner. Similar to diabetes or high blood pressure medications, if you stop using the drug, the condition is likely to come back. Once people start taking it, they will probably need to do so forever.

JONATHAN KNOWLES/GETTY IMAGES

Some older drugs block digestion of fat in foods – with nasty side-effects

MIODRAG IGNJATOVIC/GETTY IMAGES

Lifestyle changes are still important for those taking weight-loss drugs

Semaglutide is approved by the FDA for people who are obese, with a BMI of 30 or more, as well as individuals with a BMI of 27 and up – considered overweight – who also have a weight-related health condition, such as diabetes, high blood pressure, osteoarthritis or sleep apnoea. When prescribed, it should coincide with lifestyle changes like exercise and calorie-restrictive diets, says Kushner. "Obesity is a public health issue that requires a widespread public health response," he says.

Since semaglutide is relatively new and was only approved for use in weight loss last June, it is too soon to know its true effectiveness. A trial looking at the change in body weight of 304 people given the drug or a placebo over two years is already under way. Some of those who work on obesity have been prescribing the drug regularly. So far, anecdotally, "the effects from the trial are being reproduced in my patients", says Kushner.

Even so, not everyone responds in the same way. "While some patients achieve a 15 per cent or more weight loss, some only achieve a 3 per cent reduction," says Stanford. "There's high responders and low responders and those low responders may be better suited for some of the more traditional anti-obesity medications."

"Once people start taking it, they will probably need to do so forever"

Then there is the cost. At around $1500 per month, the drug is out of reach for most people in the US. Although there are hints it may be covered by the various parts of the National Health Service in the UK, it hasn't yet been approved there.

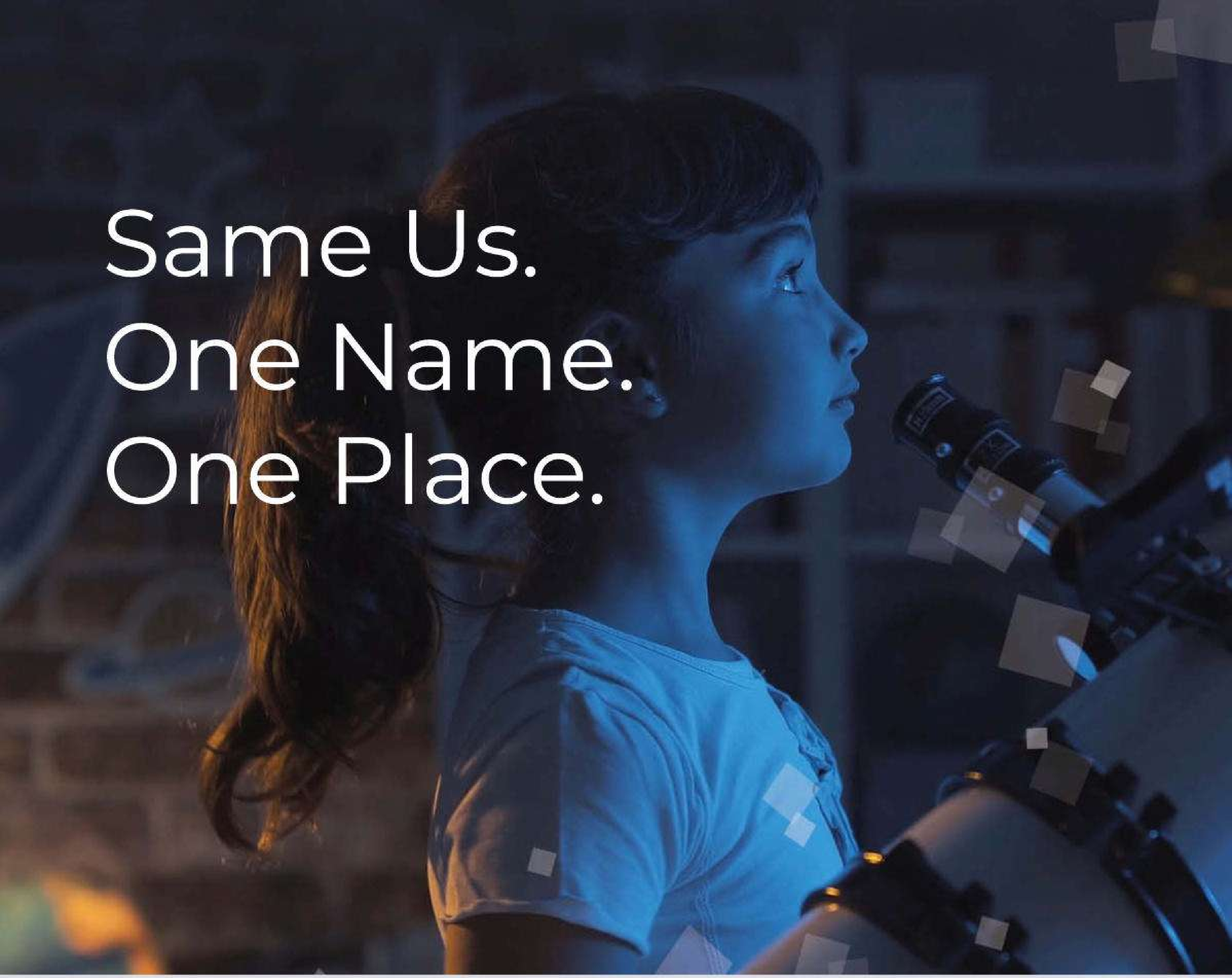
Heavy cost

Given the global cost of high BMI, estimated at $990 billion per year, a drug that could prevent obesity in high-risk people could be worth the cost. But for insurers to get on board, we must not only be sure of its safety and efficacy, says O'Neil. We will also need to eradicate antiquated stereotypes around obesity. Many still view obesity as a condition caused by a lack of willpower. Research has shown that people of all ages and professions look at people with obesity in a negative light. "We still, as a society, make assumptions about people based on their weight," says O'Neil. "The world can be very cruel to those with severe obesity."

Perhaps the biggest reason why the US state-funded healthcare programme Medicare and most private insurers in the country aren't yet covering the cost of these drugs is due to the sheer number of people who could benefit. "The market for these medications is just so big and if we cover them, it could cost a fortune," says Geoffrey Joyce at the University of Southern California. Even so, it isn't out of the realm of possibility. Bariatric surgery is now covered by Medicare at $25,000 per procedure (see "Pills vs surgery", left).

For Rhinehardt, the cost has been the biggest challenge. "My [insurance] plan will pay for [gastric] band or gastric bypass surgery twice, but not Wegovy, even with the results I'm experiencing," she says. It remains to be seen whether she can scrape together enough cash to stay on the drug that she thinks may save her life. "I want to live a long and healthy life, and I have a better shot at both if I achieve a healthy-range BMI." ▮

Sara Novak is a science journalist based in South Carolina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Brave new worlds

Comb through observations from NASA's TESS mission to help astronomers discover new planets, says **Layal Liverpool**

Layal Liverpool is a science journalist based in Berlin. She believes everyone can be a scientist, including you. @layallivs

What you need

Access to Planet Hunters TESS via zooniverse.org

Citizen science appears every four weeks

Next week

Science of cooking

NASA'S GODDARD SPACE FLIGHT CENTER

THIS month I am escaping from Earth and joining astronomers in their search for undiscovered worlds. You can too, by participating in the Planet Hunters TESS project online.

You will be asked to flick through observations from NASA's Transiting Exoplanet Survey Satellite (TESS) and look out for signs of worlds beyond our solar system. Each time one of these exoplanets passes in front of its parent star – a process known as transiting – it blocks out a small amount of the star's light.

The dimming that occurs during a planet's transit can be detected by the satellite, appearing as a dip in a graph of the star's light output. By drawing boxes around these dips on the graphs, you can help astronomers comb through the vast amounts of data generated by the satellite each month and potentially aid in the discovery of new planets.

Depending on how far a planet is from its star and the number of planets in a star system, you might notice one or multiple transits in the star's light graph. Astronomers can also use the data to work out information about a planet, such as its mass and density.

Citizen scientists participating in the project recently helped identify two exoplanets orbiting a type of star called a yellow dwarf. "We think both of the planets have really extended atmospheres," says Nora Eisner at the University of Oxford, who leads Planet Hunters TESS. This means the planets probably aren't very dense, as their atmospheres are spread out in space.

Eisner and her team published the findings in the journal *Monthly Notices of the Royal Astronomical Society*, with the citizen scientists who contributed listed as co-authors. "People get very excited when I send them an email saying, 'you helped find a planet'," says Eisner.

I am still waiting (hoping) to get that email, but the 33,800 volunteers who have taken part since the project launched in 2018 have already contributed to the identification of around 140 planet candidates.

And, although Eisner and her colleagues also use artificial intelligence to comb through the data, human observations offer something that algorithms can't.

"The exciting thing about our candidates compared to the ones the algorithm finds is that ours tend to be longer period, [meaning] it takes them longer to go around their star once," says Eisner. These planets are less likely to be noticed by the algorithm, since their longer orbital periods mean they transit less frequently. They are of particular interest to astronomers, as they are more likely to be in the habitable zone where liquid water could exist.

Eisner has yet to find any habitable zone planets, but perhaps you can help her. "Keep an eye out for things that look strange," she recommends. ▮

These articles are posted each week at newscientist.com/maker

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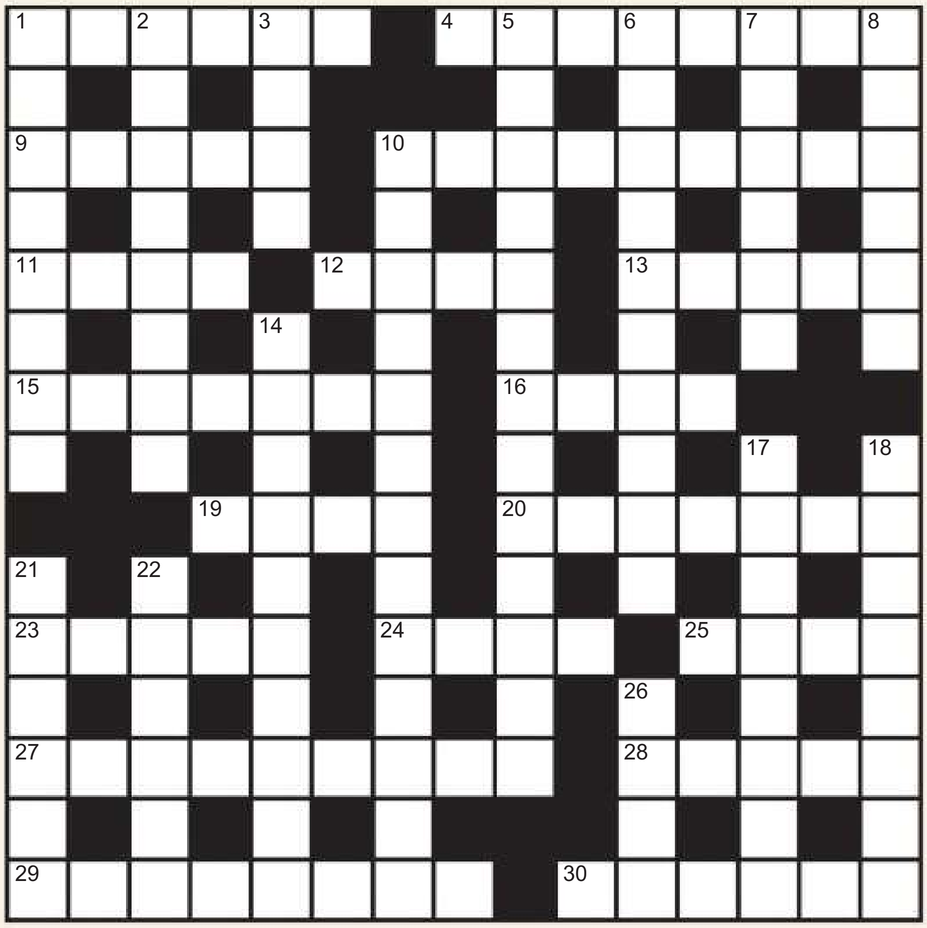
Quick crossword #107 *Set by Richard Smyth*



Scribble zone

Answers and the next cryptic crossword next week

ACROSS

1 Able to move independently (6)
4 *The* ___, 1965 sci-fi story collection by Stanisław Lem (8)
9 Judge ___, law enforcement officer in Mega-City One (5)
10 Hardening of tissue (9)
11 3D solid with six square faces (4)
12 Mackerel shark that may be shortfin or longfin (4)
13 Carnivorous African mammal (5)
15 Deposit or sediment (7)
16 River barrier (4)
19 Ne (4)
20 Yuri ___, Soviet cosmonaut (7)
23 Informal name of social networking service launched in 2010 (5)
24 Relating to a digestive orifice (4)
25 Collaboratively edited online information resource (4)
27 Dye derived from the beetle *Dactylopius coccus* (9)
28 Adult form (5)
29 Enzyme that catalyses proteolysis (8)
30 Plant also known as sweet chervil or garden myrrh (6)

DOWN

1 US federal health insurance programme (8)
2 1989 sci-fi film directed by James Cameron (3,5)
3 Ore deposit (4)
5 Insectivorous migratory bird, *Motacilla flava* (6,7)
6 Humans, perhaps (10)
7 Part of the foot (6)
8 Of a body part, not proximal (6)
10 Arcade game released in 1978 (5,8)
14 Stimulating hormone (10)
17 Supply with water, agriculturally (8)
18 Sb (8)
21 Convulsion of the diaphragm (6)
22 Prefix denoting a relation to the mind (6)
26 Flightless bird of New Zealand (4)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #150

1 Name the only astronaut who went to space with NASA's Mercury, Gemini and Apollo missions.

2 What scale is used to measure an individual's level of consciousness after a brain injury?

3 What name is given to the last stage of an insect's metamorphosis?

4 Which substance, also known as china clay, is essential to the manufacture of china and porcelain?

5 Which naturalist expanded Linnaean taxonomy by grouping classes of living things into phyla?

Answers on page 55

Puzzle

set by Holly Biming

#166 The week link

In the Zordik language, the seven days of the week start with Ardik (Monday). The other days are Bordik, Curdik, Deldik, Endik, Fordik and Gandik, but not exactly in that order.

In her Zordik class, teacher Miss Taik asked the students to recite the days in order, starting with Ardik. Sven called them out in alphabetical order.

"You got three in the right place," said the teacher. "Kim, you have a go."

"Deldik, Bordik, Ardik, Curdik, Endik, Gandik and Fordik."

"Three right again. Help them, Raki."

"Gandik, Deldik, Curdik, Bordik, Ardik, Fordik and Endik."

"Unbelievable – you only got three right as well. Still, you now have all the information you need to work out the days of the week in order."

What are they?

Solution next week

Planetary fly-through

Would it be possible to fly a spaceship through the centre of a gas giant planet?

Richard Glover
London, UK
Although gas giant planets mostly consist of gas, at depth, the pressure means this gas behaves more like a liquid and, if you go deep enough, like a solid. In addition, rocky debris from other bodies that fell into a gas giant would accumulate at its core. So a point would be reached where the "gas" would be too dense to fly through. Also, the increasing pressure and temperature would destroy any spacecraft long before the planet's centre was reached.

Damir Blazina
Chester, UK
Nobody knows for sure what is deep inside a gas giant. Assuming that the ones in our solar system – Jupiter and Saturn – are typical examples, it wouldn't be possible to fly through one due to the solid core, high temperature, high pressure and the difficulty in obtaining escape velocity.

It might be different for exoplanets known as hot Jupiters, which are gas giants orbiting close to their star. These appear to have very low density, much lower than Jupiter and Saturn. This suggests they have more gas and less liquid or solid material, so perhaps one of those would be a better candidate for a fly-through?

> "Another challenge is the temperature, which might reach 20,000°C at the centre of Jupiter. Try surviving that!"

Herman D'Hondt
Mascot, New South Wales, Australia
The gas giant Jupiter largely consists of hydrogen, with about 10 per cent helium, and the pressure at its core could be up to 100 million times that typically seen on Earth at sea level. It should be obvious that no spacecraft could survive this pressure.

Another challenge is the temperature, which might reach 20,000°C at the centre of Jupiter. Try surviving that!

There is also the possibility that Jupiter's core is rocky, although at pressures of 100 million atmospheres, there isn't much difference between rock and gas.

Mike Follows
Sutton Coldfield, West Midlands, UK
The short answer is no. The term "gas giant" is misleading. These planets aren't gas clouds, they are planets cloaked in thick, opaque atmospheres that conceal what lies beneath. While they may not have a well-defined, solid surface like that of rocky (that is, terrestrial) planets such as Earth, you shouldn't expect to be able to pass through them.

Depending on their density, even the atmospheres of planets and gas clouds could present a hazard to spaceships, which need to slow down to avoid burning up like meteors due to friction-generated heat.

When comet Shoemaker-Levy 9 collided with Jupiter in July 1994, it didn't reach the solid core, let alone appear on the other side of the planet. Instead, one fragment released energy equivalent to 6 million megatons of the explosive TNT, and the comet resulted in a fireball with a temperature peaking at about 40,000°C and a plume that reached a height of more than 3000 kilometres. For a while, this was more visible than Jupiter's Great Red Spot.

SHUTTERSTOCK/IAN DYBALL

Other than humans, are there any animals that have a sense of humour?

This week's new questions

No joke **Do any other animals have a sense of humour? If you slipped on a banana skin, are there any creatures that would laugh?** ***James Buzolic****, Coolum Beach, Queensland, Australia*

Off the boil **Why does taking a near-boiling saucepan of water off the hob immediately cause a lot of steam to be released from the water?** ***Simon Cooper****, Cambridge, UK*

Electronic biker
Cheadle, Staffordshire, UK
By the time a gas giant fly-through is attempted, our current spaceship designs will be well out of date. Use of the (by then) readily available warp drive will probably make the feat much easier.

Feel the heat

After a swim at my gym, I can choose a sauna (dry and hot) or steam room (wet and hot). Both make me sweat, so which is better for my well-being? Or are both just self-flagellation?

Joy Hussain
General practitioner and sauna researcher, Brisbane, Australia
According to responses to the online Global Sauna Survey (2016-2017) that I conducted, greater use of either steam rooms (also known as wet saunas) or dry saunas was linked to higher quality-of-life scores. Strikingly, it was the mental not the physical components of well-being measurements that were higher.

As to the differences between these hot activities, two small studies from Poland – both with only 10 participants – show how steam rooms put extra physical stress on the body. Dry saunas and steam rooms increase your skin and core body temperatures, causing various physiological changes, but these changes happen a lot faster and with more intensity in steam rooms because your sweating responses are dampened, literally.

Dry saunas stimulate sweating and steam rooms reduce our ability to sweat. You may feel like you are sweating just as much in a steam room, but the droplets on

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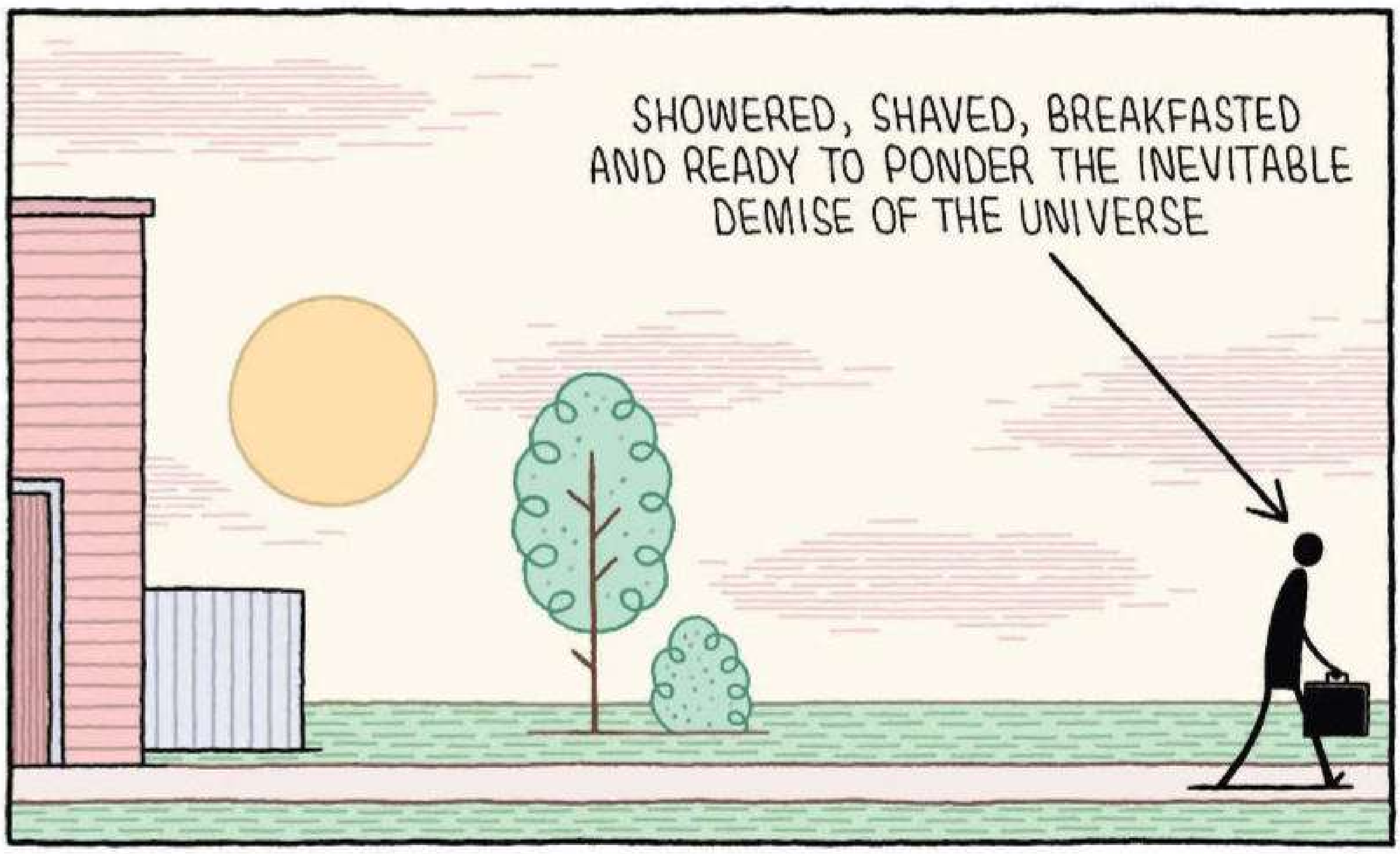

SHOWERED, SHAVED, BREAKFASTED AND READY TO PONDER THE INEVITABLE DEMISE OF THE UNIVERSE

your body are more likely to be condensed water from the humid air than perspiration.

How this affects us mentally remains to be meaningfully studied. It probably comes down to personal preference and how your mind and body react to the thermal stress of a dry sauna or steam room.

Whole-body heat exposure is known to have several similarities to exercise. Like those who prefer high-intensity exercise to low-intensity forms, there are also those who prefer steam rooms to dry saunas, and vice versa. A lot more research needs to be done to determine all the benefits (and risks) of both.

The mention of "self-flagellation" is worth further inspection. On the contrary, most sauna bathers in the Global Sauna Survey indicated enjoyment, improved sleep and stress relief as a result of their hot activities.

> **"Self flagellation? Most sauna bathers reported enjoyment, improved sleep and stress relief as a result of their hot activities"**

Jari Laukkanen
University of Eastern Finland
Both saunas and steam rooms may offer health benefits that come from heating the whole body, so the effects should be similar for both. However, our studies have only looked at the effects of dry Finnish-type saunas, where temperatures reach around 80°C.

We have found that this type of sauna bathing is associated with a reduced risk of cardiovascular disease and fatalities, as well as a lower risk of high blood pressure and strokes.

Future archive

I want to preserve scenes from my childhood (currently on DVDs) for at least the next 100 years. With technology progressing so rapidly, what is the best format for this? (continued)

Xenia Polunin
By email
When my father died in 1997, I offered his notebooks from his expeditions to the Canadian Arctic and Spitsbergen, Norway, written in the 1930s, to the British Museum. On receiving them, they told me they were so happy that he had written in pencil because it lasts longer than other methods of writing.

Russell Fulton
Auckland, New Zealand
I have read the previous answers with interest, but no one made the point that using multiple methods increases the chance of survival.

I have worked in academic IT for nearly 50 years and seen several disasters involving loss of digital data from various causes. To use an old saying: "Don't put all your eggs in one basket."

Store your treasures with several different cloud providers and, most importantly, make sure that someone is delegated to keep an eye on them when you are gone! ▮

Answers

Quick quiz #150
Answers

1 Wally Schirra
2 The Glasgow Coma Scale
3 Imago, or imaginal stage
4 Kaolin
5 Georges Cuvier

Cryptic crossword #82 *Answers*

ACROSS 1 Sagacity, **5** Drab, **8** Irate, **9** Kidneys, **11** Extract, **12** Raise, **13** Tartar, **15** Clam up, **18** Blast, **19** Recedes, **21** Freesia, **22** Innie, **23** Tote, **24** Cinnabar

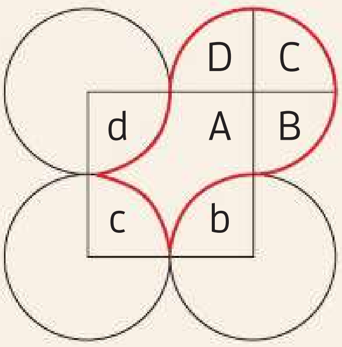
DOWN 1 Snidest, **2** Graft, **3** Coelacanths, **4** Take to, **6** Rhenium, **7** Baste, **10** Dereliction, **14** Reagent, **16** Pasteur, **17** Armani, **18** Befit, **20** Deneb

#165 Land for rent
Solution

Joining the centres of the four circles gives a square with sides of 10 metres.

As can be seen in the diagram below, the three quarter-circles b, c and d in the square correspond to the three quarter-circles B, C and D outside the square, in the area enclosed in red.

This means that the total area outlined in red fits exactly inside the square and is therefore 100 square metres.



Love in the metaverse

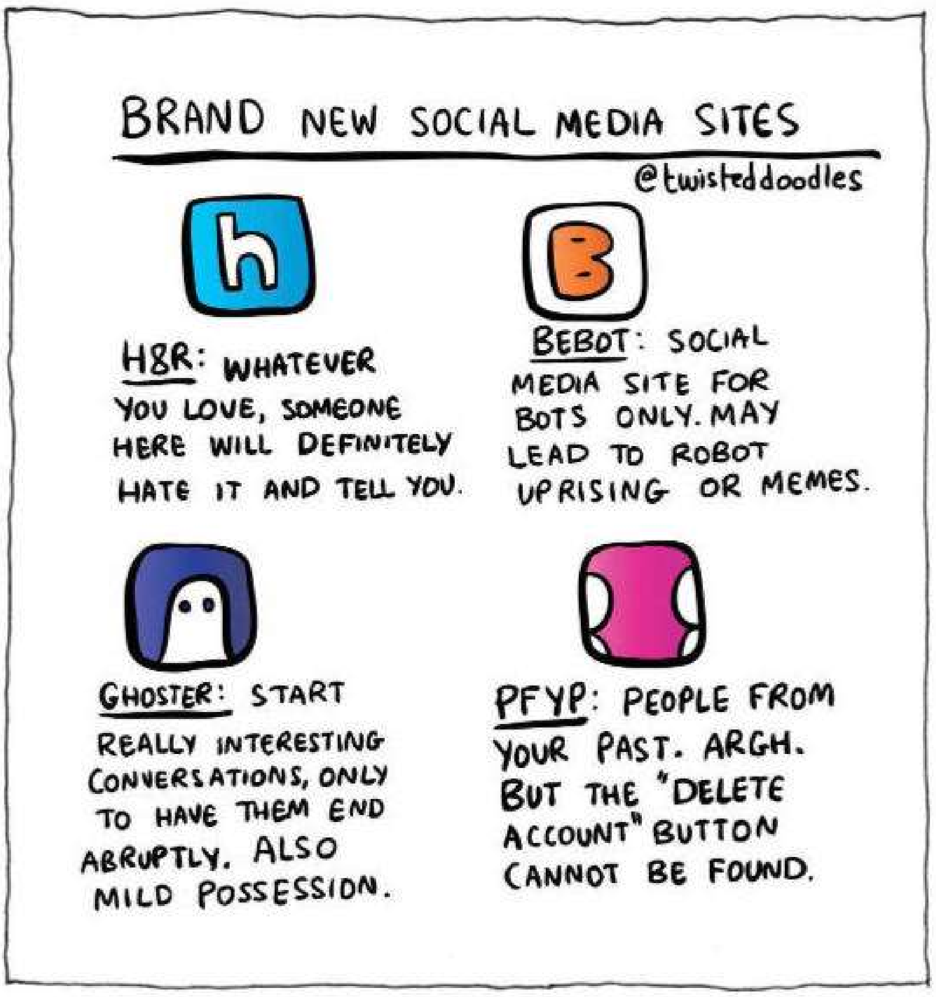
A PR writes in a breathless tone that suggests they are just back from doing something else. "For the next generation dating in the metaverse won't be optional," we read. "There will be a blurry line between an in-person date and being on video. The audio will be spatial. The video will be immersive. And video dating will change as we know it."

And Mark Zuckerberg will be hiding round a corner holding a big bucket for your most intimate secrets, ka-ching. We would bet on at least some people keeping the physical dating option open, if only because not all sensory experiences are fully available in the metaverse as yet. But never say never. History is littered with intrinsically real-world experiences we never expected to go virtual: shopping for shoes, boring people with holiday snaps, hurling abuse at strangers.

But the spatial audio bit sounds interesting. We weren't aware the metaverse equated to full-on synaesthesia. More prosaically, the PR turns out to be offering a hook-up with the CEO of a video speed-dating app for hot chat with topics including "Requirements for dating in the metaverse" – a large headset and wide turning circle, we presume – and "Cheating in the metaverse".

We are unsure whether this last one is in the sense of a "how to", or just informing us how to tell if an avatar is cheating. There must be ways. Perhaps guilty feet have got no algorithm, to misquote a poet.

Twisteddoodles *for New Scientist*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PFYP: PEOPLE FROM YOUR PAST. ARGH. BUT THE "DELETE ACCOUNT" BUTTON CANNOT BE FOUND.

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What the doctor ordered

Possibly fresh from a consultation in what we are now joining the world in misbranding as the metaverse, Andy Howe writes in concern at his doctor prescribing something that sounded very like "die, mister". We are happy to confirm that this is a nasal spray for the treatment of hay fever, one Dymista, and merely homophonically alarming.

We are altogether more exercised by the advice his daughter finds in a Google preview window under the rubric "What to do when your baby poops in the bath". "We recommend removing them from the tub and making sure to get rid of any excess water which might contain fecal matter. Once they're completely dry, give them a wash with baby-safe disinfectant or boil them in water in the same way you would sterilize a pacifier before returning them to the bath." And then be sure to throw away the baby with the... no, wait a moment. Following the trail back to its source, the advice turns out to be about bath toys, but still.

Like the sun going down

There are few more disheartening ideas for those who believe in human agency than Isaac Newton's conception of a preordained clockwork universe. This is why we are vicariously pleased as Kathy Haskard, consulting some celestial runes in her neck of the woods, discovers a website promising that the "next planned solar eclipse that will be visible from Adelaide, will take place on April 20, 2023".

We like the idea of throwing in the odd unplanned one every now and again to keep people on their toes. The errant adjective reminds Feedback of a report we once spotted in a small-town newspaper in Germany, that a spontaneous demonstration would occur on the main square at 11am on the following Tuesday, and of another clockwork certainty in keeping with our own native country's aptitude for genteel chaos: disruption for anyone so foolhardy as to attempt to travel by train on a weekend or public holiday. We are still unsure whether the dread "planned engineering works" are any less annoying than the spontaneous, self-nucleating variety, or which authority ordains they should always be precisely in our way.

Testicle tans

US TV commentator and all-round... egg Tucker Carlson has been teasing his new documentary film, *The End of Men*, with a trailer of such startling homoeroticism that it will possibly soon be banned in Florida.

Carlson's premise is that male testosterone levels are declining, that this is a bad thing and that the best way to combat it is to get your testicles tanned. Feedback's level of hormonal outrage remains middling about all of this. We are unsure of the last part, however, which seems to involve exposing private parts to infrared radiation. Hot, we suspect, and not in a good way.

Doing our due diligence, we do run across well-founded research reported in this organ in 2018 – no sniggering at the back, there – that "The higher your testosterone levels, the more you love soft rock". On that basis, anything that accidentally ends up reducing them is probably all to the good.

Woke-o-saurus

Meanwhile, in the UK, *The Sun* reports that David Attenborough's new one-off CGI-enhanced documentary *Dinosaurs: The Final Day* features a "softer 'woke' version of the T-Rex". "Predators tend to just fight all the time and we wanted to show them pooing," the article quotes executive producer Helen Thomas as saying. This mystifies us, as that wasn't on our list as a specifically woke activity.

We suspect this might annoy those dinosaurs who like their *T. rex* raw in tooth and claw and think the world's gone to the dogs since the mammals have been in charge, or whatever. We also suspect the final day of the dinosaurs would have been a good one for a spot of testicle tanning. Doesn't seem to have done them any good, mind. ■

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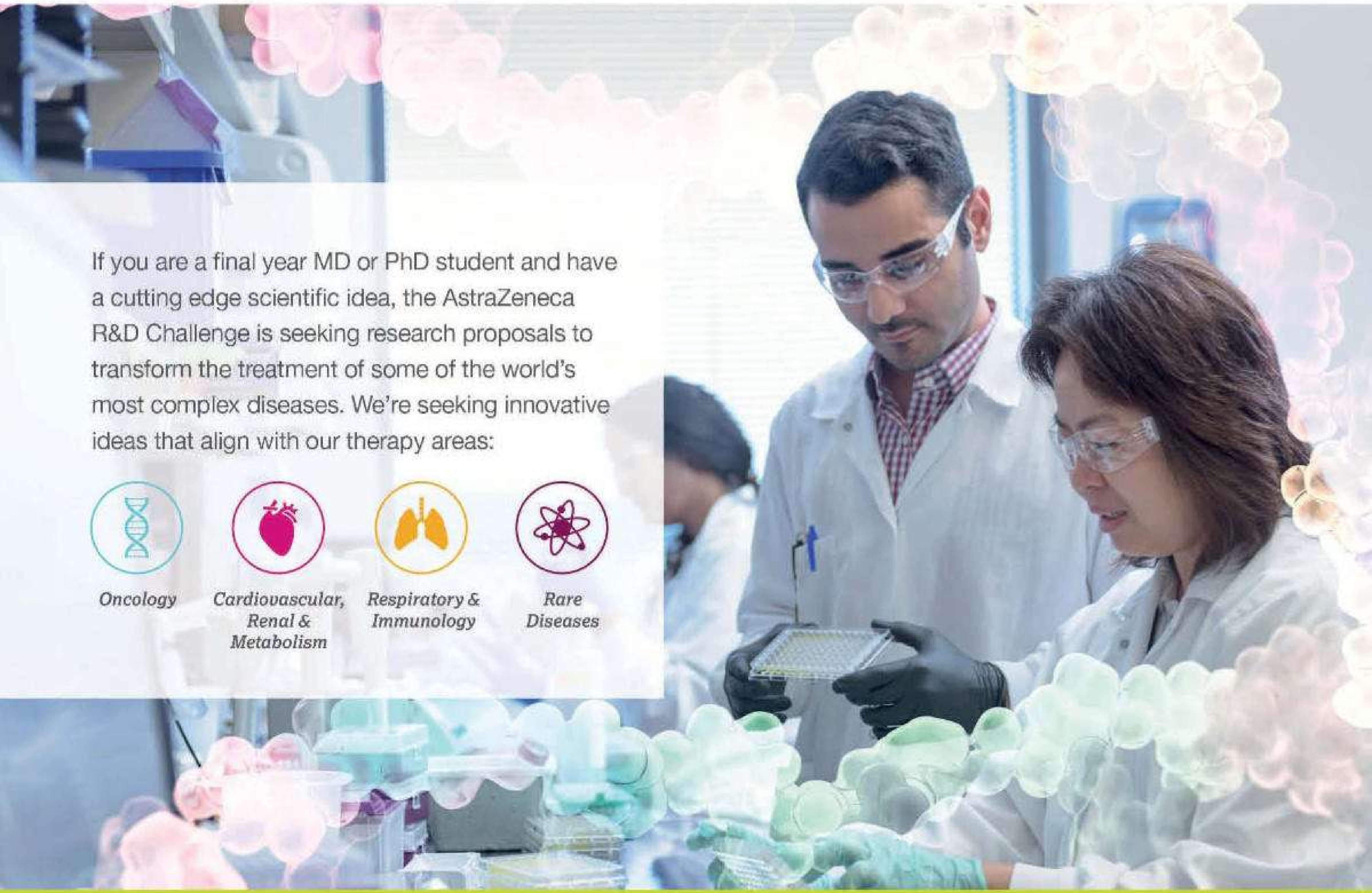

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